The Engineer

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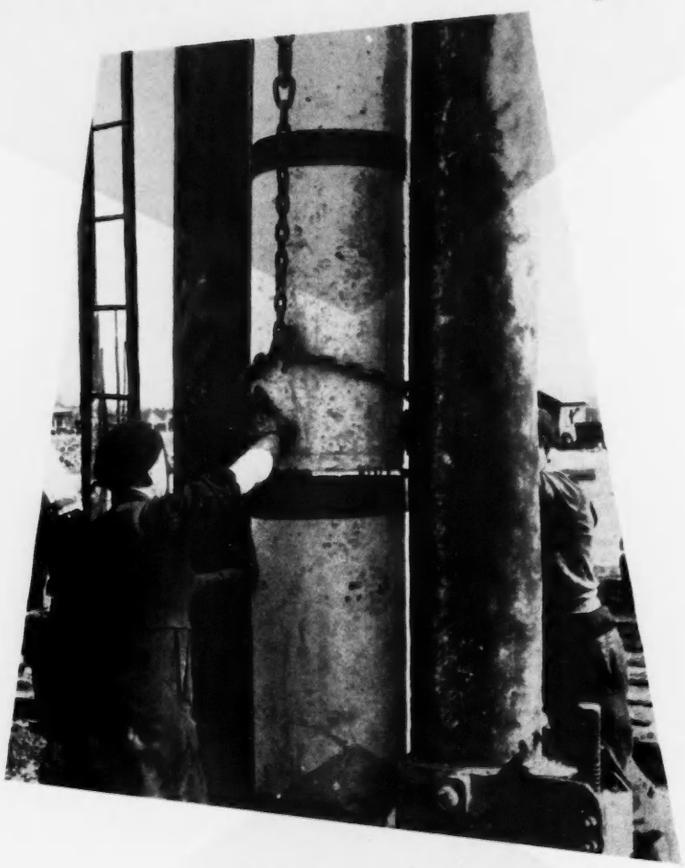

The sectional nature of the pile is illustrated in the photograph, which shows pile sections being assembled prior to driving

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Established 1856

No. 5369 **DECEMBER 19, 1958** VOL. 206

EDITORIAL CONTENTS

Leading Articles

Clear Thoughts About Railways . . . 951
Financing Electricity Supply . . . 951
Training for Industry . . . 952
Works Relations . . . 952
Beginnings in Medical Research . . . 953

Articles

100 Years Ago . . . 953
V. S. Swaminathan Middle East Oil . . . 954
O. S. Nock Mechanics of Train Running . . . 960
F. P. Potocki Vibrating-Wire Strain Gauge for Long-Term Internal Measurements in Concrete . . . 964
Chimney Plumes . . . 970
The Brinsworth Hot Strip Mill . . . 971
Roll Grinding Machine . . . 973
High Production Automatic Moulding Machine . . . 975
Radioactive Laboratory for Isotope Work . . . 976
Transmitting Magnetic Compass . . . 977
Marine Centrifugal Pumps . . . 978
" Television " Equipment for Boiler Water Level Checking . . . 978
New Data Processing System for Harwell . . . 978
Hydrostatic Tractor . . . 979
Heating Coils for Tankers . . . 979
Vacuum Furnaces . . . 980
Heavy-Duty Flash Butt Welding Machine . . . 980
Hydraulically-Operated Testing Machine . . . 980
South African Railway Electrification Progress . . . 982
Fifty Years of Tata Iron and Steel Company . . . 983

Continental Section

Continuous Flow Crystalliser . . . 984
Gyratory Crusher . . . 984
5000-Ton Floating Dock . . . 984
Non-Slipping Taper Joints . . . 984

American Section

National Metal Congress and Exposition. No. II . . . 985
Road-Making Equipment . . . 987

LETTERS Training for Design . . . 968

BOOK REVIEWS . . . 968

OBITUARY R. T. Rolfe, O.B.E. . . . 969

NEWS AND NOTES Technical Reports . . . 977
Industrial and Labour Notes . . . 981
Personal and Business . . . 988
British Patent Specifications . . . 989
Launches and Trial Trips . . . 990
Forthcoming Engagements . . . 990
Advanced Engineering Courses . . . 990

INDEX TO ADVERTISERS : PAGE 123 **CLASSIFIED ADVERTISEMENTS : PAGE 116**

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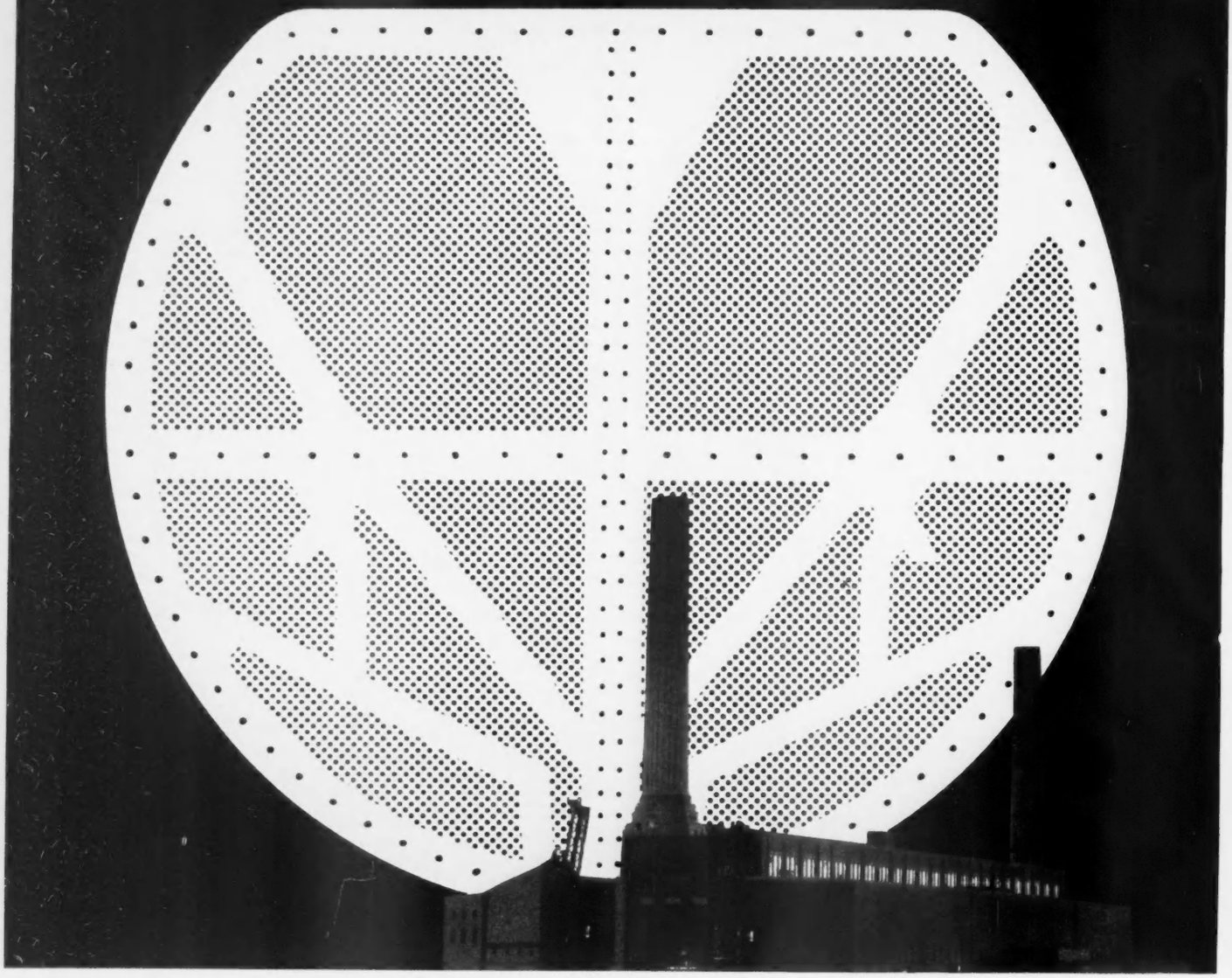

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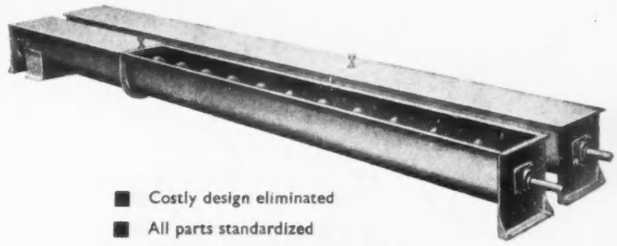

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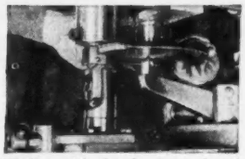

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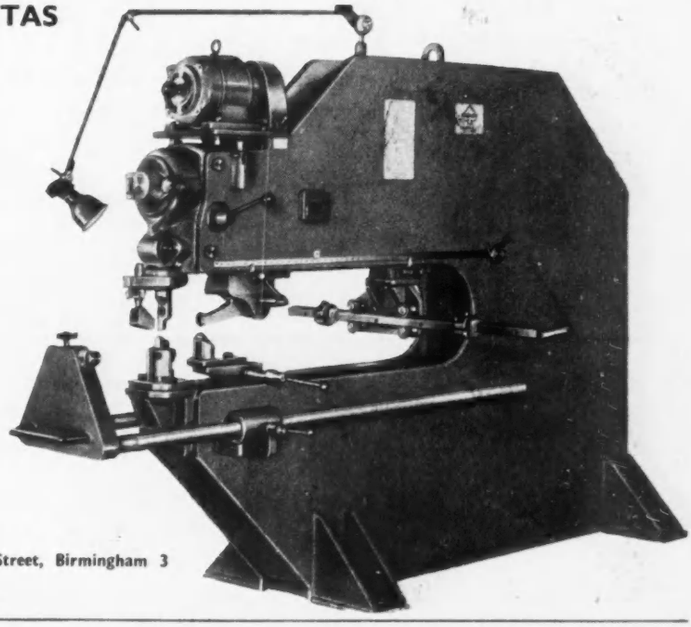

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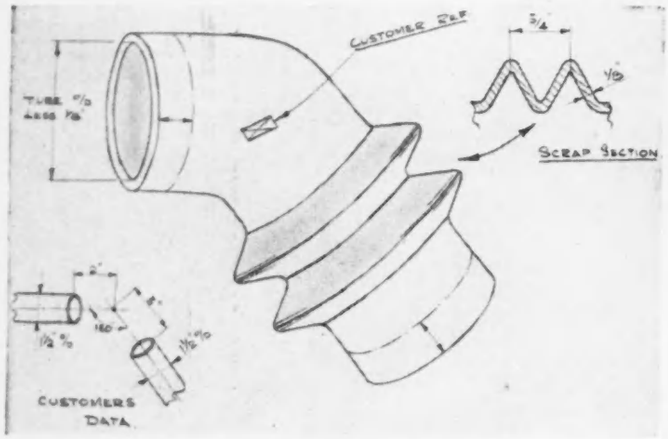

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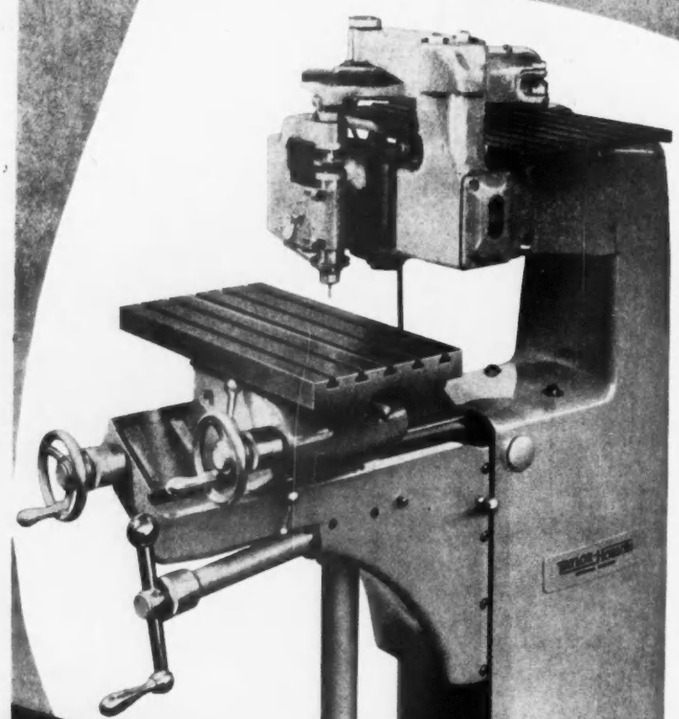

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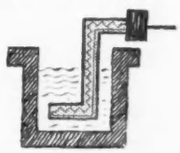
Electrical Aids in Industry *Data Sheet* **No. 5**

Resistance Heating – 2

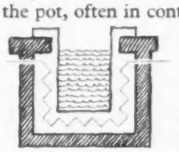
Electric resistance heating elements have been briefly described in Data Sheet No. 4, with two examples of their application in industry. This sheet lists some of the further applications which can be effectively dealt with by resistance heating.

Soft Metal Melting

Electric resistance melting is most commonly used for lead, tin, zinc, antimony, aluminium and their alloys—in processes such as tinning, type-casting, die-casting and lining bearings—at temperatures of up to around 800°C.



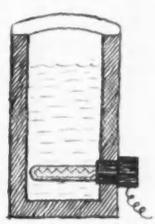
In most cases, sheathed elements are immersed directly in the metal, a more efficient method than applying heat to the outside of the containing vessel or pot. Immersion heating simplifies the application of lagging to the outside of the vessel, reducing heat losses and current consumption to a minimum. The elements are usually positioned near the inside wall of the vessel, leaving plenty of working space, but in a few cases, where the full volume of the pot is required, or where the metal to be melted is particularly corrosive, the elements are positioned outside the pot, often in contact with it.



In all cases, the precise temperature control that is so essential in soft metal processes is readily achieved by the use of electricity, and electric heating also leads to a reduction of casting rejects and metal wastage and a marked improvement in working conditions.

Liquid Heating

Electricity provides the ideal way of heating liquids such as water, oils, varnishes, plating, photographic and other solutions, and of melting and heating waxes and compounds, glues and pastes, tars and bitumen. Again, immersion heating is the method most commonly employed, but considerations of space or the nature of the liquid may sometimes necessitate the use of external heaters. Several types of devices are available to give precise and automatic temperature control, and lagging is again commonly applied to the vessel to minimise heat losses.

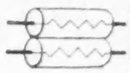


Fire hazards associated with inflammable liquids are invariably reduced by electric heating, particularly if immersion heaters can be used.

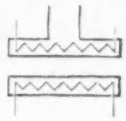
It is usually possible without difficulty to apply electric heaters, either immersion or external, to existing vessels.

Platen, Press and Roll Heating

Electricity offers the simplest and most convenient method of heating platens, dies and rolls. It gives the precise temperature-control characteristic of electric heating systems, with lower maintenance costs. Moreover, the relatively high temperatures required in some processes for maximum working speeds are reached without difficulty. Flexible electrical connections to moving parts give far less trouble than flexible pipe connections carrying hot water or steam.

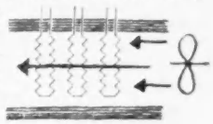


When electric heating is used, one or more presses can be operated without the necessity of keeping a boilerhouse staff at work.



Air Heating

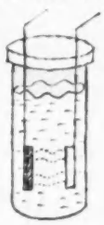
Streams of air, and of many other gases, can be heated most efficiently by electric resistance elements disposed across the duct leading to or from a fan. Heat is generated only inside the duct, just where it is required, and none is carried away through exhaust flues or pipes. Quick rise of temperature and precise temperature control are assured when electric resistance air heaters are used.



Electric Steam Boilers and Steam Raising

There are many cases when the use of electricity for steam raising is fully justified on economic grounds.

The means employed for bringing steam from a boilerhouse to the point of usage are often extremely wasteful, but where electricity is used the steam can be generated on the spot and losses from steam mains are eliminated. The efficiency of the electric boiler normally exceeds 96% and is practically constant at all loads, while the rapidity with which steam can be raised very largely eliminates banking losses.



Plant requiring process steam can be equipped with its own electric steam boiler, freeing the working space of steam mains just as individual electric motor drives free the factory of masses of shafting and belt drives.

Even where boilerhouse steam is still used, it is sometimes desirable for best results to boost the steam temperatures at the point of usage, to make up for transmission heat losses or to increase the superheat, and this function can most conveniently be performed by an electric resistance heater inserted in the steam line.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, W.C.2. Telephone: TEM 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available – "Resistance Heating" is an example; "Induction and Dielectric Heating" is another.

E.D.A. also have available on free loan a series of films on the industrial use of electricity. Ask for a catalogue.

5816

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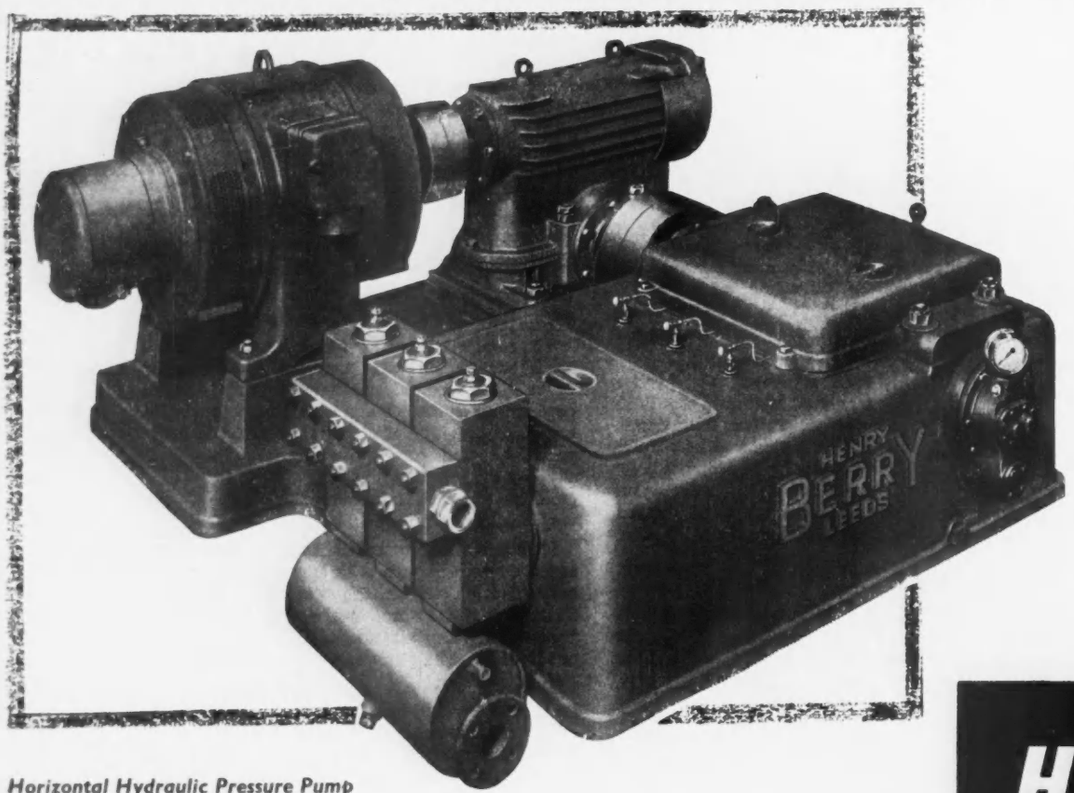

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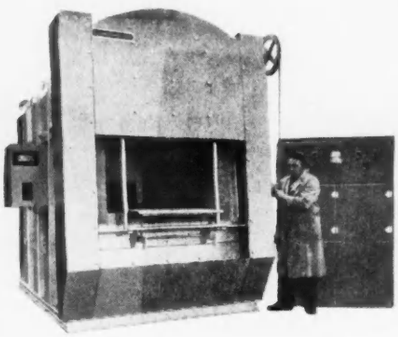

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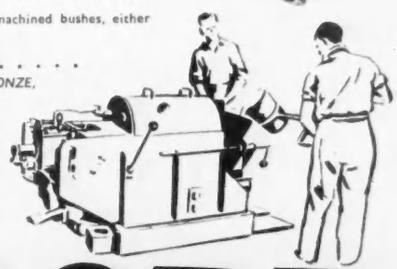

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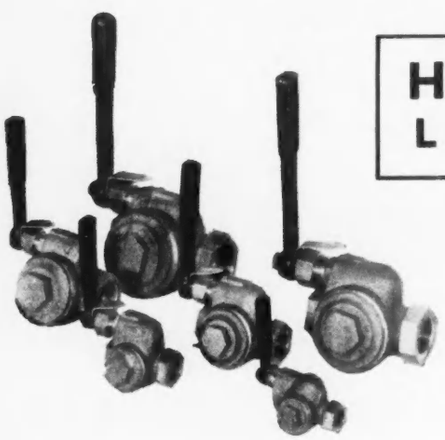

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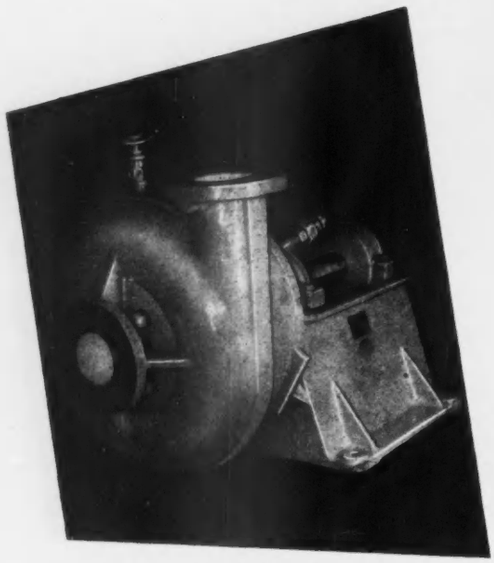

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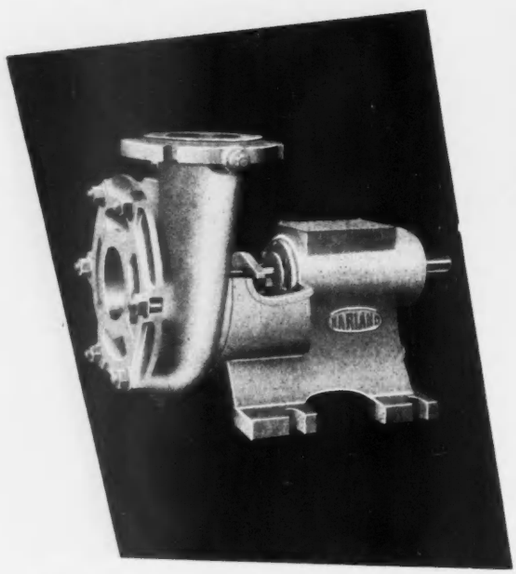

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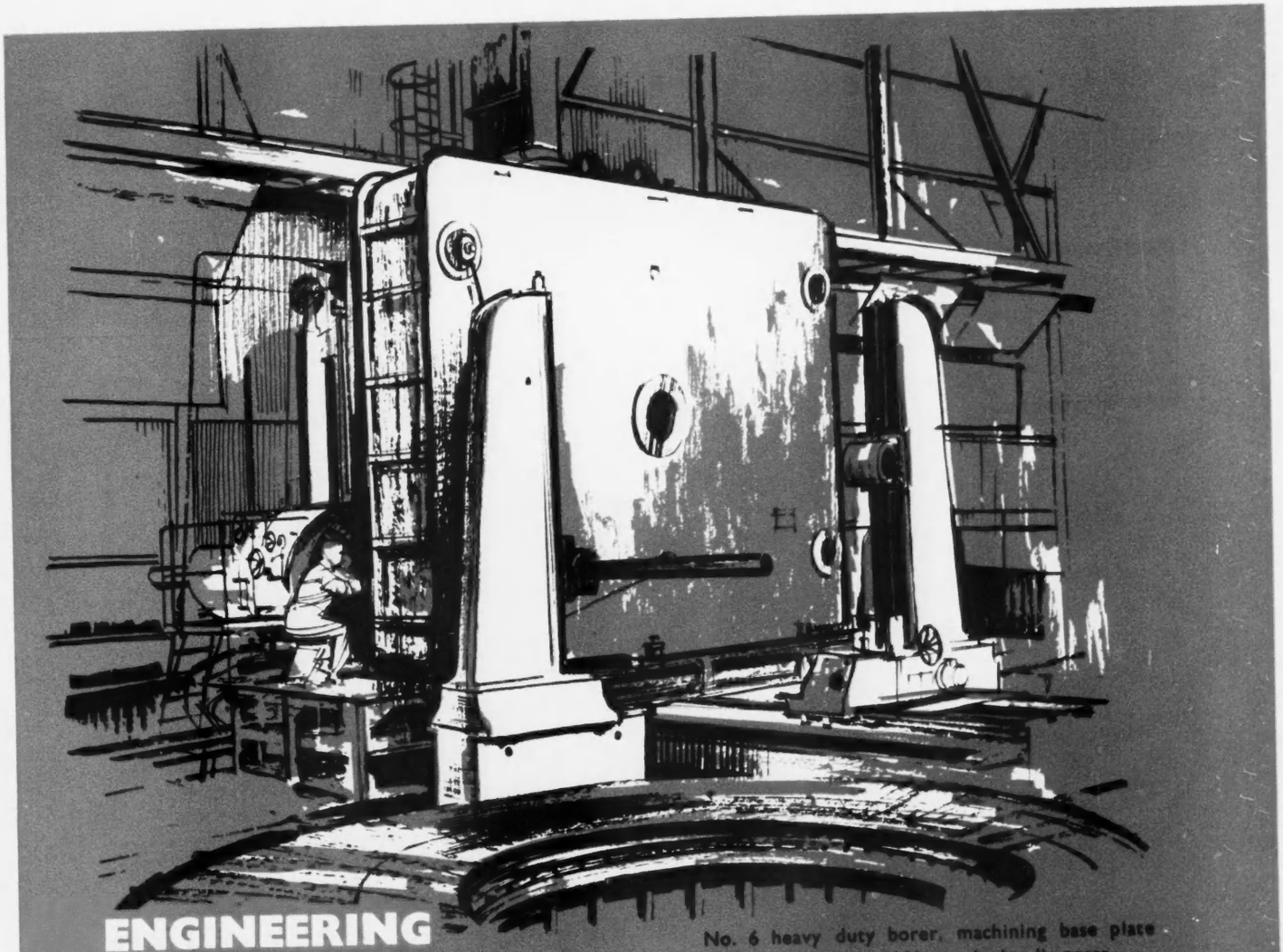
LONDON AND EXPORT SALES OFFICES: HARLAND HOUSE, 20 PARK STREET, W.1.

BRANCHES IN: BRISTOL, GLASGOW, LEEDS, NEWCASTLE, NOTTINGHAM, TIMPERLEY (Cheshire), WOLVERHAMPTON AND OVERSEAS

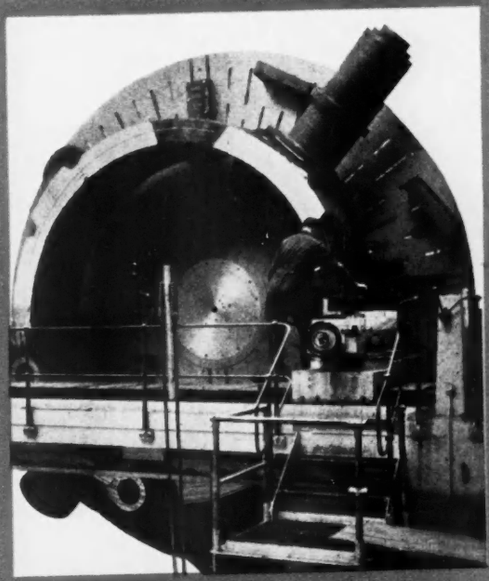


ENGINEERING

No. 6 heavy duty borer, machining base plate 17'10" x 13'3" for a 1100 ton hydraulic press.

DEVELOPMENTS

Machining facilities for heavy capital equipment are being extended by the development of an entirely new site, the South Works, at Stockton-on-Tees, where an additional 200,000 sq. ft. of buildings are equipped for machining heavy pieces up to 100 tons in the manufacture of equipment for the chemical, gas, petroleum, nuclear energy and iron making industries.



Large face plate centre lathe, swinging 32'0" dia. up to 100 tons.

ABP

ASHMORE, BENSON, PEASE & COMPANY

ASSOCIATED WITH THE POWER-GAS CORPORATION LIMITED

STOCKTON-ON-TEES AND LONDON

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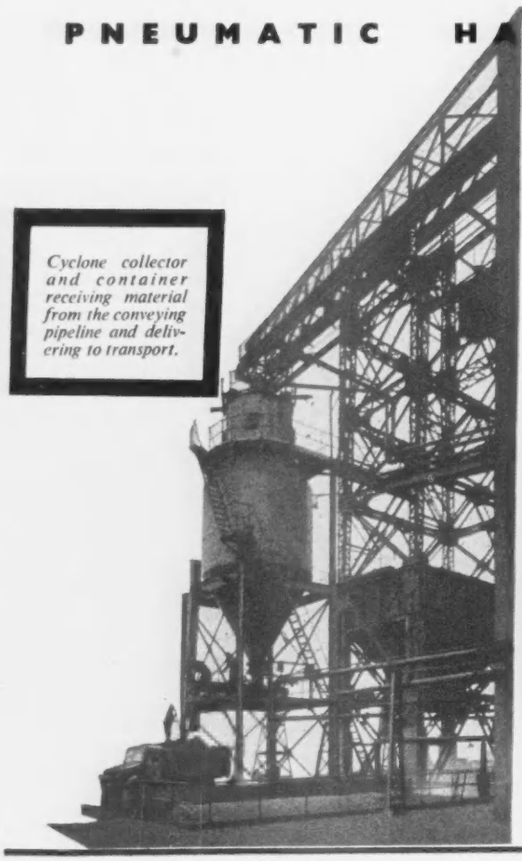
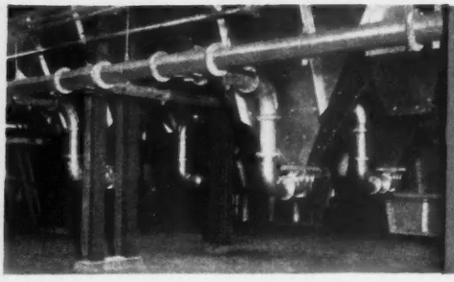
377

PNEUMATIC HANDLING *of materials*



Cyclone collector and container receiving material from the conveying pipeline and delivering to transport.

A pneumatic suction or blowing system is an ideal means for the conveyance of powdered or dusty materials, for it is totally enclosed. The system is particularly suitable for collecting material from a number of loading points. Overall flexibility of the John Thompson Industrial Constructions systems eases the problems of applying pneumatic suction or blowing plants to existing installations. Being itself a totally enclosed system, civil engineering work is limited. Control of collection and conveyance can be manual or automatic. If automatic, individual push button stations for each component, centred in a panel, can be positioned at a suitable vantage point. John Thompson Industrial Constructions Limited undertake preparation of complete schemes for discussion purposes and our technical advice is freely given.



Aerator valves through which material is loaded from hoppers into the conveying pipeline.

JOHN THOMPSON INDUSTRIAL CONSTRUCTIONS LIMITED

2 PRINCES RO'W BUCKINGHAM PALACE ROAD LONDON S W 1

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ICH/3

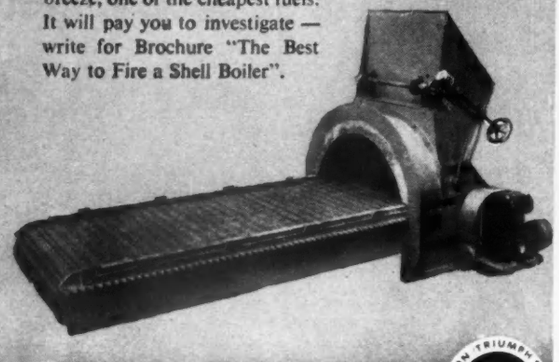
Efficient Burning of *low grade fuel* in Shell Boilers

John Thompson Triumph Travelling Grate Stokers and handling plant serving five boilers at Joseph Sankey & Sons Ltd., Bilston. Consulting Engineers for this new boiler plant were Messrs. Powell Duffryn Technical Services Ltd.

THE THOMPSON TRIUMPH TRAVELLING GRATE STOKER

Steam engineers to-day are faced with the problem of maintaining the required output of steam with fuel which is variable in quality, dear in price and often of the lowest grade. Here is one answer: it is possible to burn even the cheaper low grade fuels efficiently and completely with the Thompson Triumph Stoker.

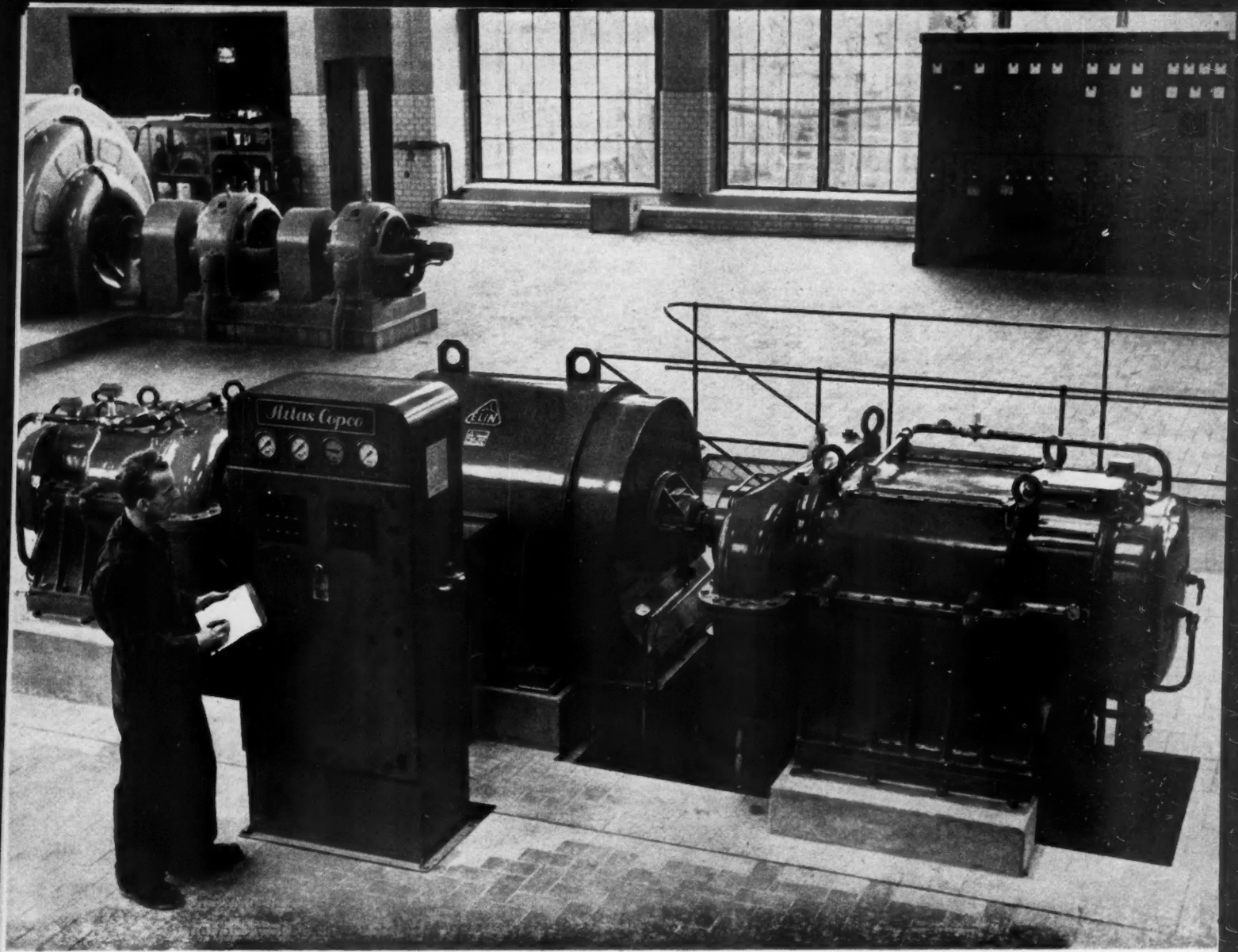
A modified Thompson Triumph Travelling Grate Stoker is available which will successfully burn coke breeze, one of the cheapest fuels.
It will pay you to investigate — write for Brochure "The Best Way to Fire a Shell Boiler".



JOHN THOMPSON (TRIUMPH STOKER) LIMITED · LEEDS

JOHN THOMPSON GROUP

TP 1



An Atlas Copco 'Twin-Air' rotary screw compressor (8,100 cfm) recently installed at the Grängesberg mine, central Sweden.

Tested for two years in Arctic Circle iron mines

THE NEW 'TWIN-AIR'
ROTARY SCREW COMPRESSOR

At Kiruna, in the arctic circle area of Northern Sweden, where the world's largest underground mine is being developed, Atlas Copco rotary screw compressors have been running under full operating conditions for two years.

Simple design, easy maintenance

The Atlas Copco 'Twin-Air' rotary screw compressor is technically simple with few moving parts. As there is no metallic contact between the compression components, need for overhauls are infrequent and little maintenance is necessary.

High efficiency

The high efficiency of the rotary screw compression system means reduced operating costs.

Lower installation costs

The 'Twin-Air' rotary screw compressor occupies less floor space than most other machines of equal capacity. This means marked savings in installation costs. Smaller high speed electric motors also contribute to initial cost saving.

Less sensitive to impure air

Free of any metallic contact between compression components, the rotary screw machine is less sensitive to impure air than any other design.

Oil-free air or gas

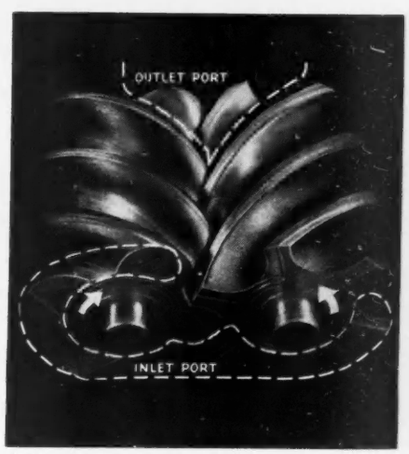
As no lubricant is necessary in the compression chamber, the rotary screw compressor delivers completely oil-free air or gas.

Smooth air flow

The design of the Atlas Copco 'Twin-Air' rotary screw compressor gives a smooth air flow. No 'surging' or 'pumping' characteristics.

Models up to 16,000 c.f.m.

The Atlas Copco standard range of 'Twin-Air' screw compressors includes models up to 16,000 c.f.m. for pressures up to 115 p.s.i. Also available as vacuum pumps.



A pair of rotors with inlet and discharge ports indicated by the dotted lines.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex, or Atlas Copco AB Stockholm 1, Sweden

C.218

super finishing

close tolerances

Telehoist have developed production techniques to attain high surface finishes combined with close tolerances, where zero backlash and low friction are design fundamentals.

The illustration shows an H. M. Hobson feel-simulator jack which is used in conjunction with servo operated flying controls. The surface finish of the piston, cylinder and spherical bearing is 1-1½ micro inches. The concentricity and clearance between working surfaces are within .0002 inches. The assembled units are tested at temperatures of — 40°C. and + 70°C.

If you have a production application demanding zero backlash and low friction characteristics we should be pleased to investigate and advise.

The illustration is shown by courtesy of H. M. Hobson Limited

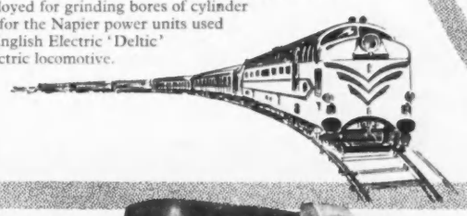
Telehoist

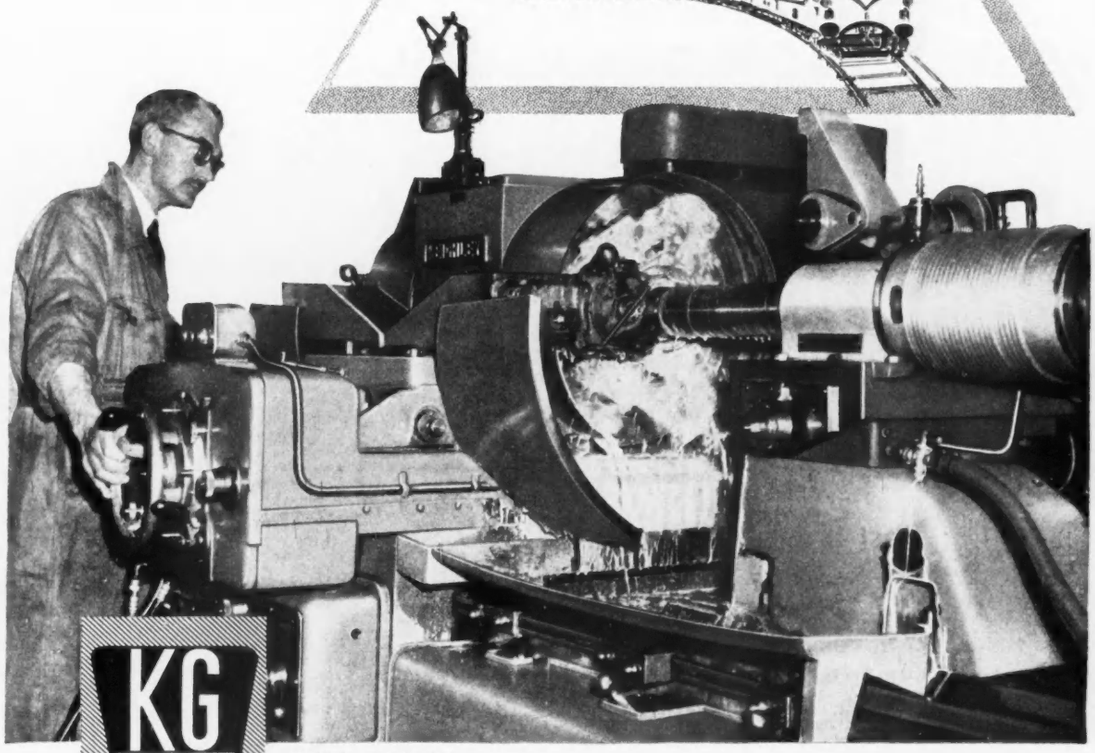
are skilled in precision production engineering and super finishing

Telehoist Ltd, Manor Road, Cheltenham, *are an associate company of Wilmot Breeden Ltd.*

precision made for constant service

Typical of special purpose grinding machines built to customers' requirements for modern production methods, this Keighley heavy duty double-head internal grinder is one of a series with an outstanding record of reliability and steadily maintained accuracy installed by D. Napier & Son Ltd., Liverpool. Designed to meet exacting standards of precision combined with production economy, the machine is employed for grinding bores of cylinder liners for the Napier power units used in the English Electric 'Deltic' diesel-electric locomotive.





KG MACHINE TOOLS

MANUFACTURE a comprehensive range of precision cylindrical, internal and universal grinders and build special purpose machines

KEIGHLEY GRINDERS (MACHINE TOOLS) LTD KEIGHLEY

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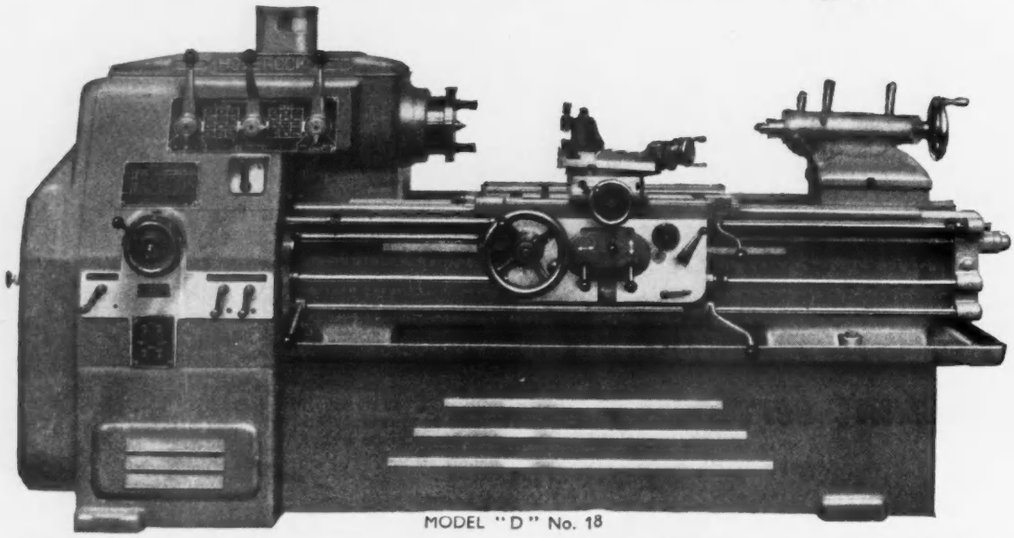
STRATFORD **Holbrook** LONDON



MODEL "D" No. 18

PRECISION TOOL-ROOM LATHES

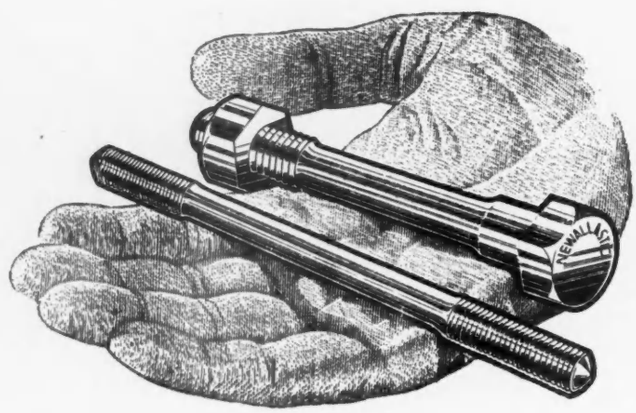
MODEL "D"

BUILT IN 3 SIZES. SWINGING 13-15-18 INCHES OVER BEDWAYS

The Finest Lathe in its Class

Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.



C. P. Newall & Co., Ltd.

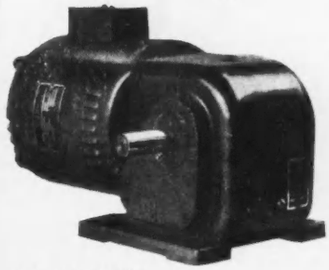
POSSILPARK · GLASGOW · N.

famous for forgings of

all descriptions
in alloy and Carbon Steels
(all heat treatment facilities)

T. S. FORSTER & SONS LTD
FORGEMASTERS AND ENGINEERS
COPPERAS BANK FORGE, SUNDERLAND
TEL: 2876 'GRAMS 'FRAMES' S'LAND

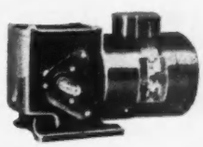
right-angled geared motors



NECO right angle drive geared motors are units of compact design especially suitable for applications where space is limited. There is a wide range of output speeds and gearing is by worm, or worm and spur reduction, according to type of unit.

Patent applied for

NEW TYPE DR GEARED MOTOR
Type DR geared motors have ball bearing oil-immersed worm and wheel, with additional spur reductions. Motors of 1/6, 1/4, 1/3 or 1/2 h.p., for 3 phase, single phase or D.C. supplies, are fitted to the one-piece cast-iron gearbox. Final shaft speeds are from 15.6 r.p.m. to 305 r.p.m. Speeds down to 0.05 r.p.m. with a maximum torque of 100 lb.-ft. are available.



TYPE SW 1/8 h.p. motors, 3 phase, single phase, or D.C., final shaft speeds between 270 r.p.m. and 0.055 r.p.m. Maximum output torque is 25 lb.-ft. below 14.8 r.p.m.

TYPE W 1/8, 1/4 or 1/3 h.p., 3 phase, single phase, or D.C. Final shaft speeds from 270 r.p.m. down to 90 or 45 r.p.m. according to output.

NECO TRADE MARK

geared motors
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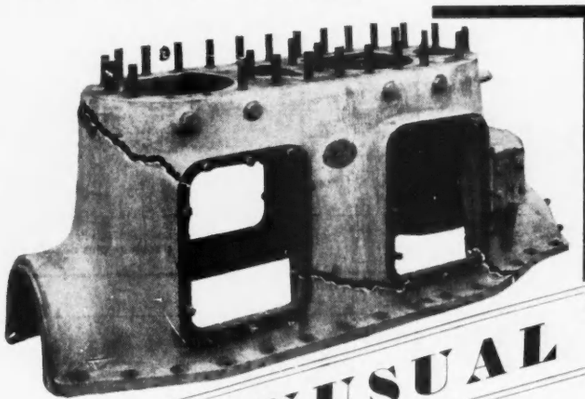
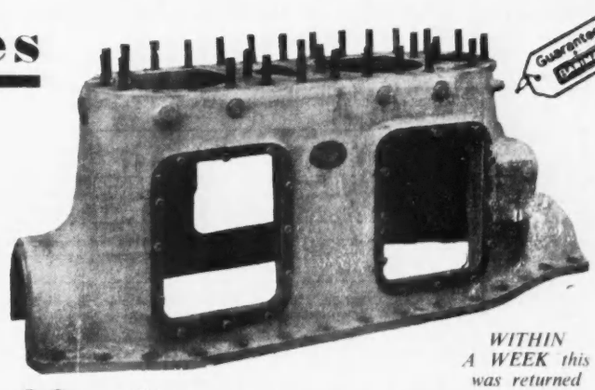
204 QUEENSTOWN ROAD · LONDON · S.W.8
Telephone: MACaulay 3211-4
Subsidiary of Normand Electrical Company Limited

BARIMAR restores



UNUSUAL



WITHIN A WEEK this was returned

Air Compressor Crankcase

Air Compressor Crankcase; the picture shows only some of the damage Barimar had to repair.

Damaged Compressors of all types come within the range of Barimar Scientific Welding—large and small, from the familiar tyre inflators to the very large compressors used by the big industrial undertakings. Quite a number of these come to Barimar from overseas customers. Damaged main castings, and the smaller parts of many kinds of compressors, have come to Barimar, but these pictures are unique—for Barimar have never before had a crankcase of an air compressor of this design—or of one damaged like it—in their Works. The three lengthy cracks graphically reveal the damage in the first illustration. There were similar cracks on the other side, and the damage was so severe that the casting was practically severed in half! The welding, therefore, had to withstand the full strain on the casting and by the time Barimar expert welders had completed the job, it certainly did so. The alignment was restored, the casting re-machined where necessary, and the crankcase was ready for instant service. A difficult repair, and a "rush job," as the compressor formed part of a big installation in a great oil refinery operating day and night. Barimar returned the crankcase within a week. The welding was strong and beautifully finished; the cost, infinitely less than that of a new replacement! This vital job of welding also included the repair of the broken cylinder head of the compressor, and, by the time the crankcase was ready, this other job was completed as well. Barimar promised the owners that the repairs would stand up to the most strenuous service. Their *Money-back Guarantee* confirmed that assurance, too! Barimar—Hall Mark of Superb, Dependable welding. When time is vital and standstills must be reduced to a minimum, 'phone Barimar at any hour of the day or night. Expert advice—without obligation—always at your disposal. When broken parts cannot be transported Barimar experts promptly operate "on the spot."

All transportable broken parts sent to London or provincial branches must be *CARRIAGE PAID*, with sender's name and address on labels. All fittings must be removed, and instructions sent by post.

BARIMAR LTD.

Barimar House,
22-24, Peterborough Road,
FULHAM, LONDON, S.W.6

Telephones: RENown 2147–2148. (Night) 2148. Telegrams: "Bariquamar, Walgreen, London."

BARIMAR Branch Addresses:
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BARIMAR—THE WORLD'S SCIENTIFIC WELDING ENGINEERS

'CORTITE'

SPECIAL PROCESS IRONS

Cortite Irons give DENSITY and PRESSURE TIGHTNESS, coupled with HIGH STRENGTH and GOOD MACHINABILITY IN ALL SECTIONS OF THE CASTING in spite of extreme variation of thickness

TYPICAL PHYSICAL PROPERTIES OF "CORTITE" SPECIAL PROCESS IRONS

CORTITE IRON		Minimum TENSILE Strength Tons sq. inch 1·2" diam. Bar	Minimum TRANSVERSE Rupture Tons sq. inch 1·2" diam. Bar	COMPRESSION Strength Tons sq. inch	IMPACT Strength Izod ft. lbs.	BRINELL Hardness No.	Modulus of ELASTICITY lbs. sq. inch × 10⁶	SPECIFIC GRAVITY	Coefficient of Thermal EXPANSION Linear × 10⁶ 0–600°C.	TORSIONAL STRENGTH lbs. sq. inch	FATIGUE STRENGTH Tons sq. inch	The equivalent British and American Standards		PATTERN SHRINKAGE Inches per foot
Class	Grade											B.S.S. 1452/1956	A.S.T.M.	
HIGH DUTY ENGINEERING	E	14	26	56	10	170–190	12–15	7·20	—	—	5·0	14	25–30	1/10
	D	17	30	68	15	180–210	16–18	7·25	—	34,000	7·0	17	35–40	1/10
	C	20	36	75	20	200–240	18–20	7·40	—	51,000	9·0	20	40	1/8
	B	23	40	80	25	220–280	18–20	7·45	—	60,000	10·0	23	50	1/8
	A	26	45	90	30	260–340	18–20	7·45	—	73,000	11·0	26	60	1/8–3/16
HEAT RESISTING	HR.1	14	26	56	10	100–170	10–12	7·00	12·8	—	—	—	—	1/10
	HR.2	20	36	75	20	200–240	18–20	7·40	12·8	—	—	—	—	1/10–1/8
	HR.3 (Silal)	12	—	—	—	210–280	17–45	6·9–7·2	12·9	—	—	—	—	1/8
WEAR RESISTING	W.R.B.	20	36	75	20	240–280	18–20	7·40	—	—	—	—	—	1/8
	W.R.A.	26	45	90	30	260–340	18–20	7·45	—	—	—	—	—	1/8–3/16
CORROSION RESISTING	C.1	18	30	62	10	180–210	12–15	7·15	—	—	—	—	—	1/10
	C.2	15	28	58	10	180–210	12–15	7·15	—	—	—	—	—	1/10

TYPICAL APPLICATIONS OF "CORTITE" SPECIAL PROCESS IRONS

CORTITE IRON		TYPICAL APPLICATIONS	Minimum Casting Thickness	HEAT TREATMENT (optional)
Class	Grade			
HIGH DUTY ENGINEERING	E	Gear Cases, Light Valves, Gears, Electrical Components, Bogie Wheels, etc. ; in fact, wherever a soft grey iron is called for.	1/8"	For stress relief heat slowly to 450–500° C. Hold at this temperature for one hour per inch of section. Cool slowly.
	D	Valve Bodies, Gates, Covers, Medium Machine Bedplates, Chucks, Gears, and Housings ; Cylinder Liners, Blocks, and Manifolds. All medium size high-pressure castings.	1/4"	
	C	Turbine Casings, Condenser Bodies, Tyre Moulds, Marking-off Plates, Propellers, Flywheels, Pump Bodies, Pistons, Large High-pressure Valves, Steam Chests, Biological Shields, Gears, Large Machine Bedplates, Headstocks, etc.	3/8"	For improved strength and toughness oil-quench at 850° C and temper at 300°–500° C to remove quenching stresses Grades C and B only.
	B	Diesel and Compressor Bodies (handling high-pressure ammonia and Freon gas), High-pressure Valves, Oil Well Castings, Slush Pumps, Gears, Machine Tool Components, Rocking Links, Highly Stressed Hydraulic Castings, Winch and Winding Drums, Rolls, etc.	1/2"	
	A	Crankshafts, Camshafts, Mixershafts, Dies, Rolls, Atomic Engineering Pressure Vessels, Shields, and Casings ; Brake Drums, High-pressure and High Strength Castings.	1/2"	For high tensile and machinability can be held at 300°–350° C, for six hours plus one hour for each inch of thickness.
HEAT RESISTING	HR.1	Intermittent Heat and Severe Thermal Shock, Chills, Ingot Moulds, Slag Pots, Annealing Glass Moulds, Fire Doors, Casings, Pig Moulds, Melting Pots, etc.	3/8"	—
	HR.2	High Duty Castings for use at temperatures up to 550° C, High-pressure Valves, Superheater Headers, Glass Moulds, etc.	1/2"	—
	HR.3	Castings working at temperatures up to 900° C, Valves, Fire Bars, Annealing Boxes, Furnace Parts. These castings are brittle at room temperature.	1/2"	—
WEAR RESISTING	WR.B	Chute Liners, Crane Wheels, Mill Wheels and Blades, Mixing Pans, Gears. Easily machinable.	1/2"	Can be oil-quenched at 850° C and tempered at 300°–500° C.
	WR.A	Mixer Blades, Wheels and Pans, Die Blocks, Cams, Gears, Liners, Rolls. High strength coupled with abrasion resistance.	1/2"	For high hardness castings, to improve machinability hold at 300°–350° C, for six hours plus one hour for each inch of thickness.
CORROSION RESISTING	C.1	Concentrated acid-resistant Pumps, Valves, etc.	1/4"	—
	C.2	Alkali-resistant Pumps, Valves, Caustic Pots, Evaporators, etc.	1/4"	—

New Alloys and Metallurgical Techniques employed in the process of producing these irons ensure consistent results, so that designers may rely upon the accuracy of the technical information given on the chart

ROBERT CORT & SON LTD

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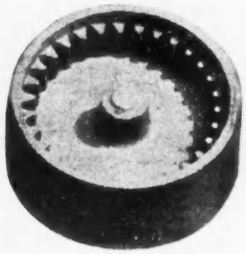
CASTINGS
IN 'CORTITE' IRON



GEAR DRUM—GRADE E
These teeth must be cast true. They are not machined and must mesh perfectly.

CORTS THROTTLE VALVE—GRADE C.

PUMP CASTING—GRADE D.—(For Hayward, Tyler & Co., Ltd., Luton).

This 53 cwt. Vertical Compound Oil Cargo Pump is for use in tankers and handles 750 t.p.h. of oil. It is tested at 350 lb. p.s.i. for a working pressure of 200 lb. p.s.i.

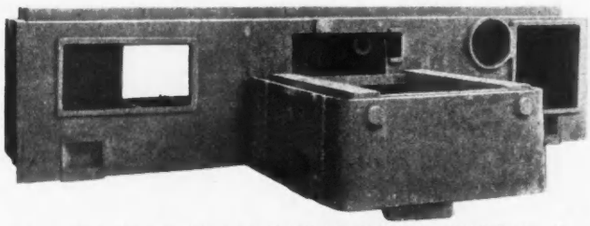
All the cores and the mould are made by the CO_2 process, which gives an excellent finish and ensures that the dimensions of cored holes are exact.

COMPRESSOR CYLINDER FOR REFRIGERATION EQUIPMENT—GRADE B.—(For Lightfoot Refrigeration, Ltd., Wembley).

This 15½ cwt. six-cylinder reon compressor casting must be completely flawless. The cylinders and crankcase, which are cast in one piece to ensure perfect alignment, are subject to hydraulic tests of 300 and 600 lb. p.s.i. respectively and gas tests of 250 lb. p.s.i.

MIXERSHAFT — GRADE A.—(For Winkworth Machinery, Ltd., Staines).
This Casting must be very strong, and 100% sound, to withstand severe Torque, replacing a steel casting.

CORTS DOUBLE GATE VALVE—GRADE HR.2
For use in hot gas main at temperatures of 550°-600° C.



BEDPLATE FOR GEAR CUTTING MACHINE—GRADE C.—(For W. E. Sykes, Ltd., Staines).

This 3-ton, 12ft. long bedplate casting is only ⅜in. thick and requires a very accurate mould and core, which, again, is achieved by the use of CO_2 process. Over 50 cores are needed to produce the intricate internal chambers.

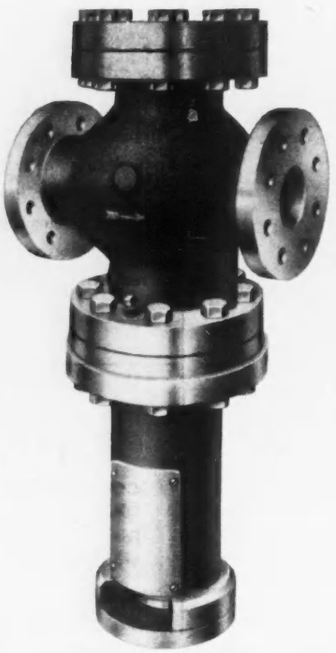
ROBERT CORT & SON LTD
IRONFOUNDERS TEL: READING 81659 READING, BERKS.

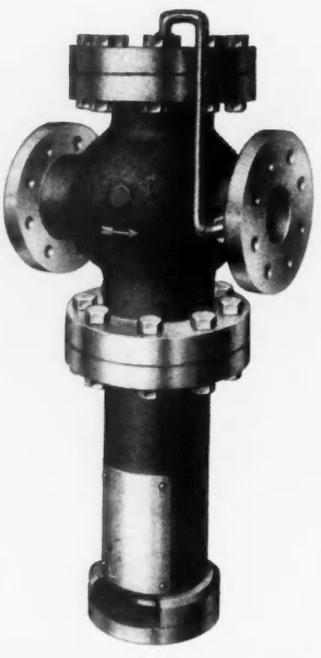
for industrial applications

A range of high quality reducing valves, combining simple, robust construction with favourable control characteristics. Available in cast iron, bronze, carbon steel or stainless steel with an extensive choice of trim materials, interchangeable

PRESSURE REDUCING VALVES

trim types and sizes, and interchangeable control springs, they provide efficiently for a wide variety of applications on liquids, steam or gas service. In the majority of sizes the back pressure regulator form is also available.





Body sizes : $\frac{3}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., (full or reduced area trim). Connections : screwed, B.S.P. or A.P.I; flanged, B.S.T. or A.S.A. Overall operating range: temperatures up to 600°F; inlet pressures up to 1200 psig; reduction ratios from 1.2 : 1 to 250 : 1. Maximum outlet pressure : 350 psig.

For full particulars see publication No. 228A.

Body sizes: 1 in., $1\frac{1}{2}$ in., 2 in., $2\frac{1}{2}$ in., 3 in., 4 in., 6 in., 8 in., (full or reduced area trim). Connections: flanged B.S.T. or A.S.A. Overall operating range : temperatures up to 600° F, inlet pressures up to 300 psig., reduction ratios from 1.2 : 1 to 10 : 1, maximum outlet pressure 50 psig.

For full particulars see publication No. 231.

Body sizes: 1 in., $1\frac{1}{2}$ in., 2 in., $2\frac{1}{2}$ in., 3 in., 4 in., 6 in., 8 in., (full or reduced area trim). Connections: flanged B.S.T. or A.S.A. Overall operating range: temperatures up to 600° F, inlet pressures up to 300 psig, reduction ratios from 1.2 : 1 to 6 : 1, maximum outlet pressure 250 psig.

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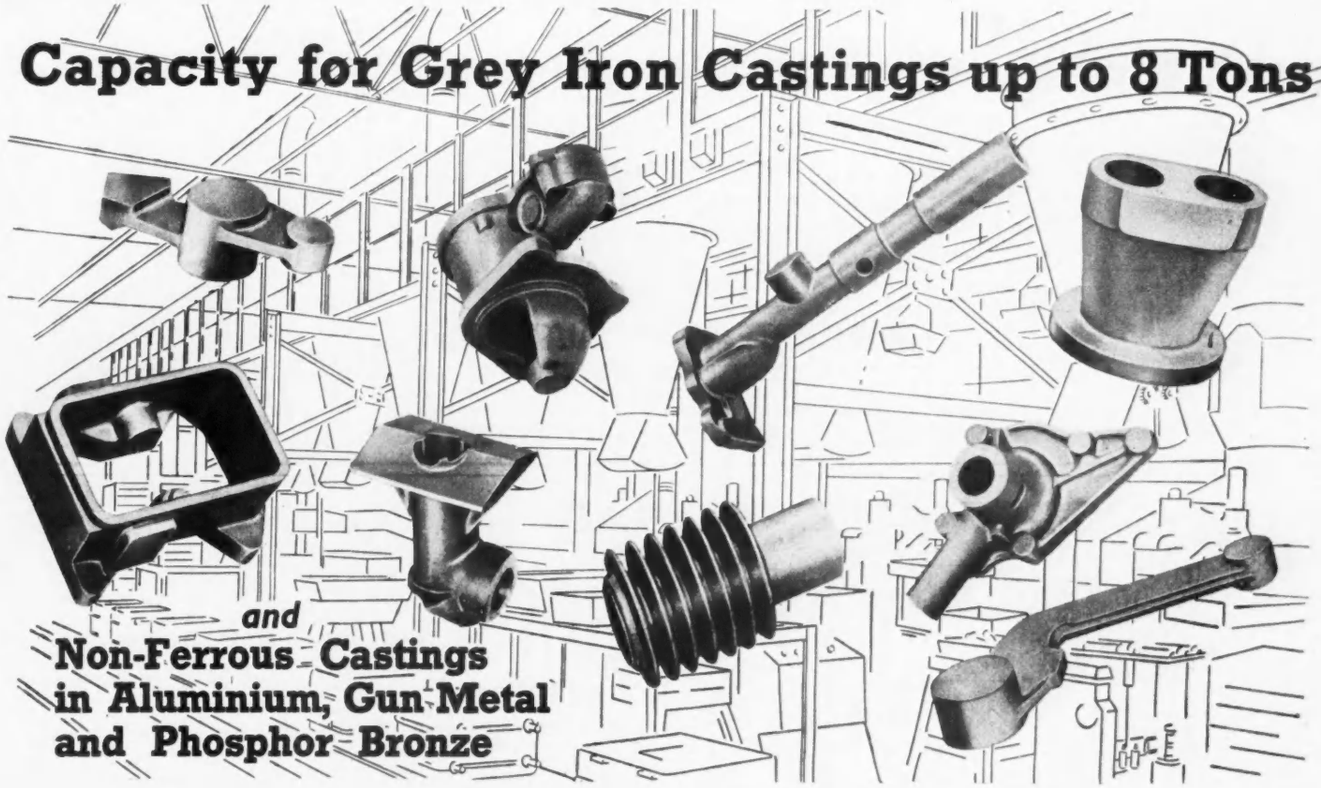

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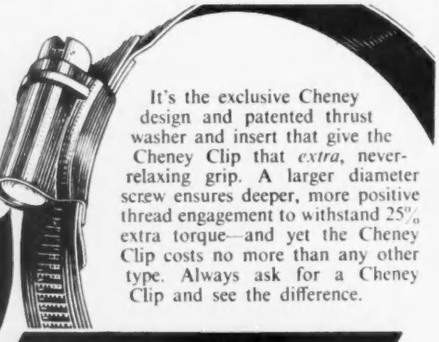

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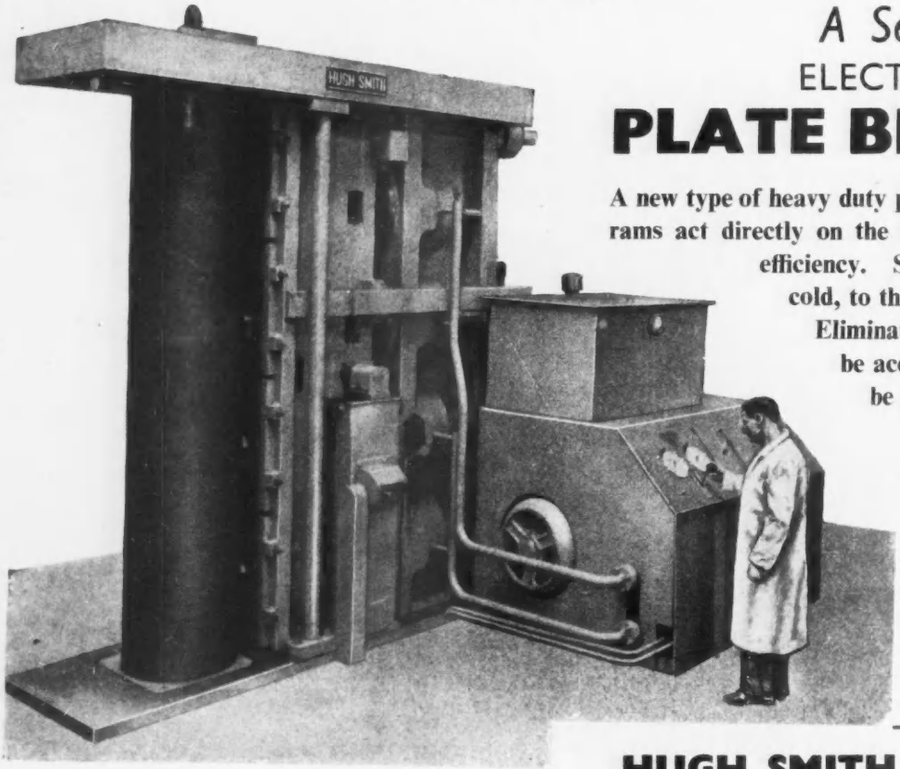

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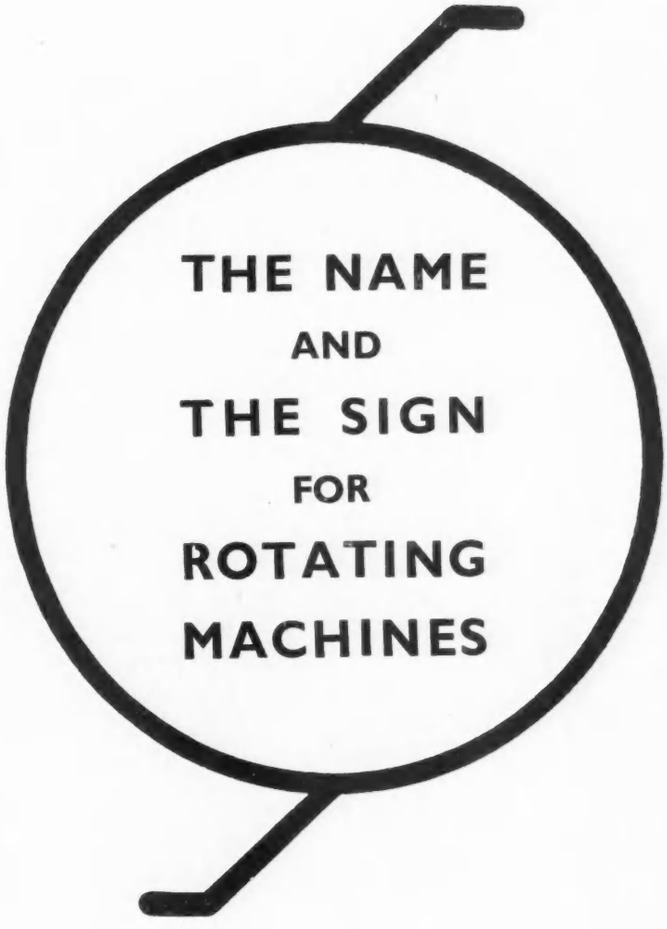

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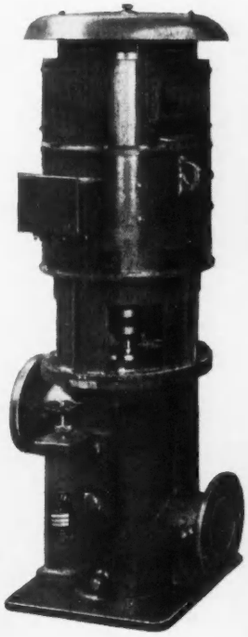

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or

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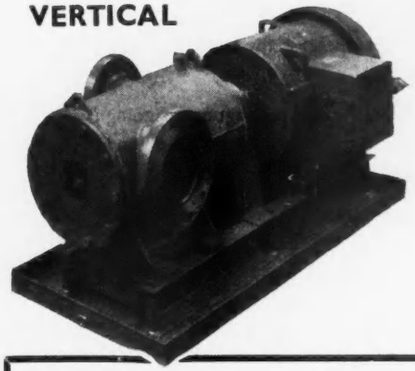

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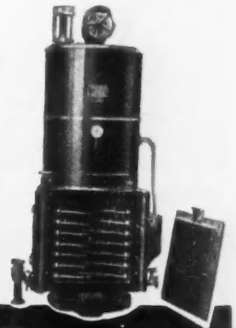

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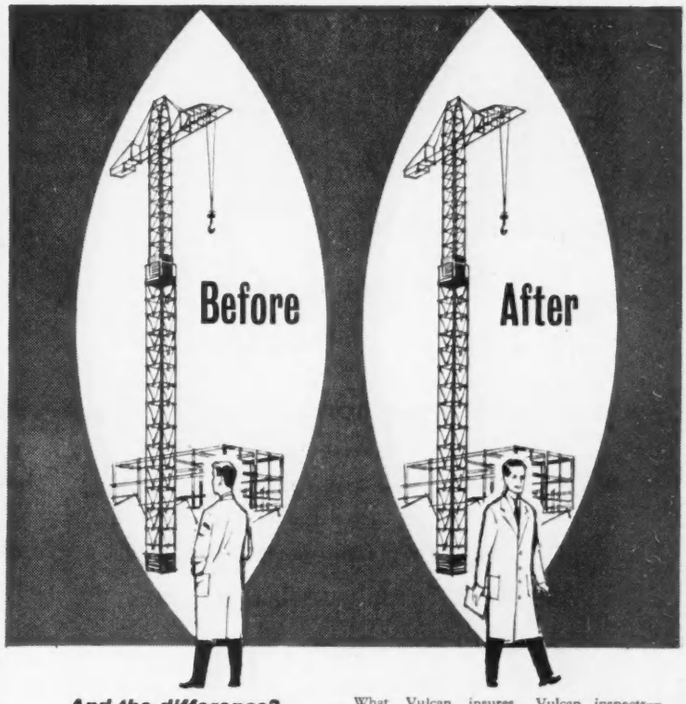

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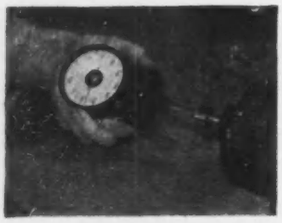

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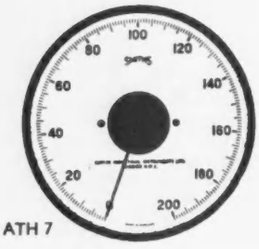

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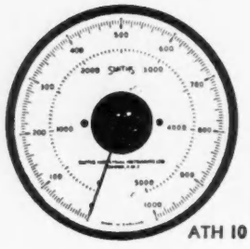

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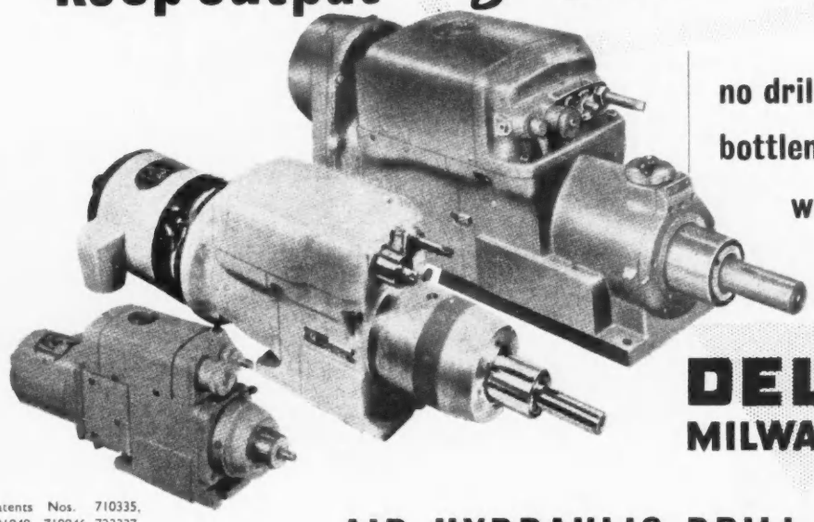

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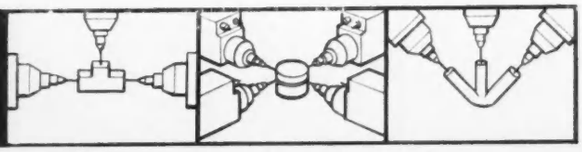

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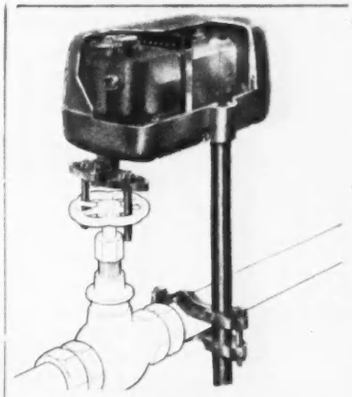

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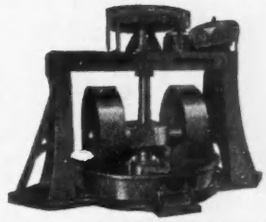

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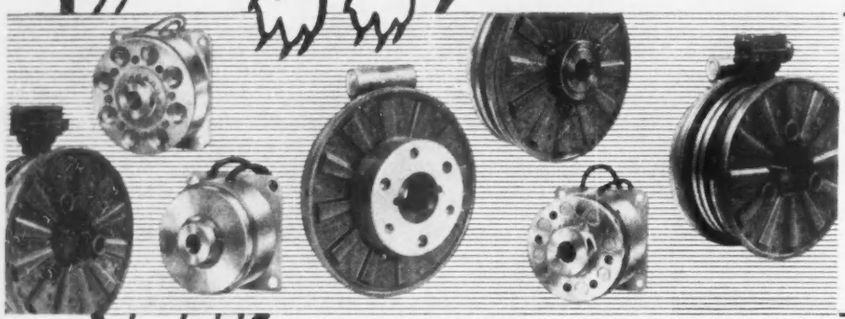

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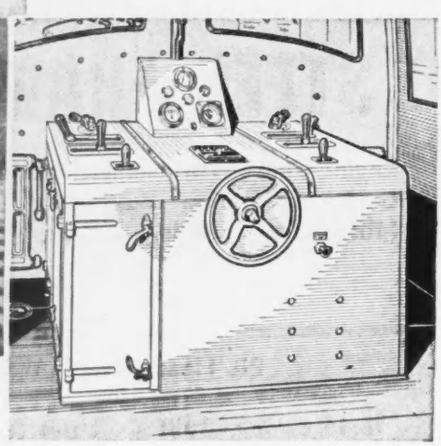

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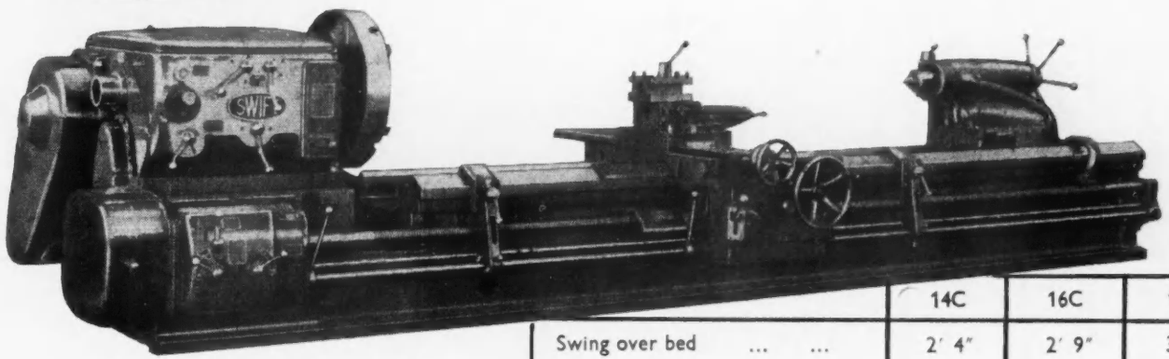

The illustration below shows two Swift "C" type lathes installed in the machine shops at Babcock & Wilcox Ltd., Renfrew. These lathes have adequate power, rigidity, and wide range of spindle speeds to take full advantage of carbide tools and for heavy duty cutting with high speed steel tools. The Swift "C" type lathe is built in three sizes shown opposite.

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Swing over bed	2′ 4″	2′ 9″	3′ 3″
*Length of bed	12′ 6″	15′ 0″	16′ 6″
Min. between centres ...	6′ 3″	8′ 3″	9′ 9″
Swing over saddle	17½″	22½″	28½″
Swing in gap (if required) ...	4′ 0″	4′ 6″	5′ 0″
H.P. recommended for average duty	15	20	25

* Beds can be supplied to any length.

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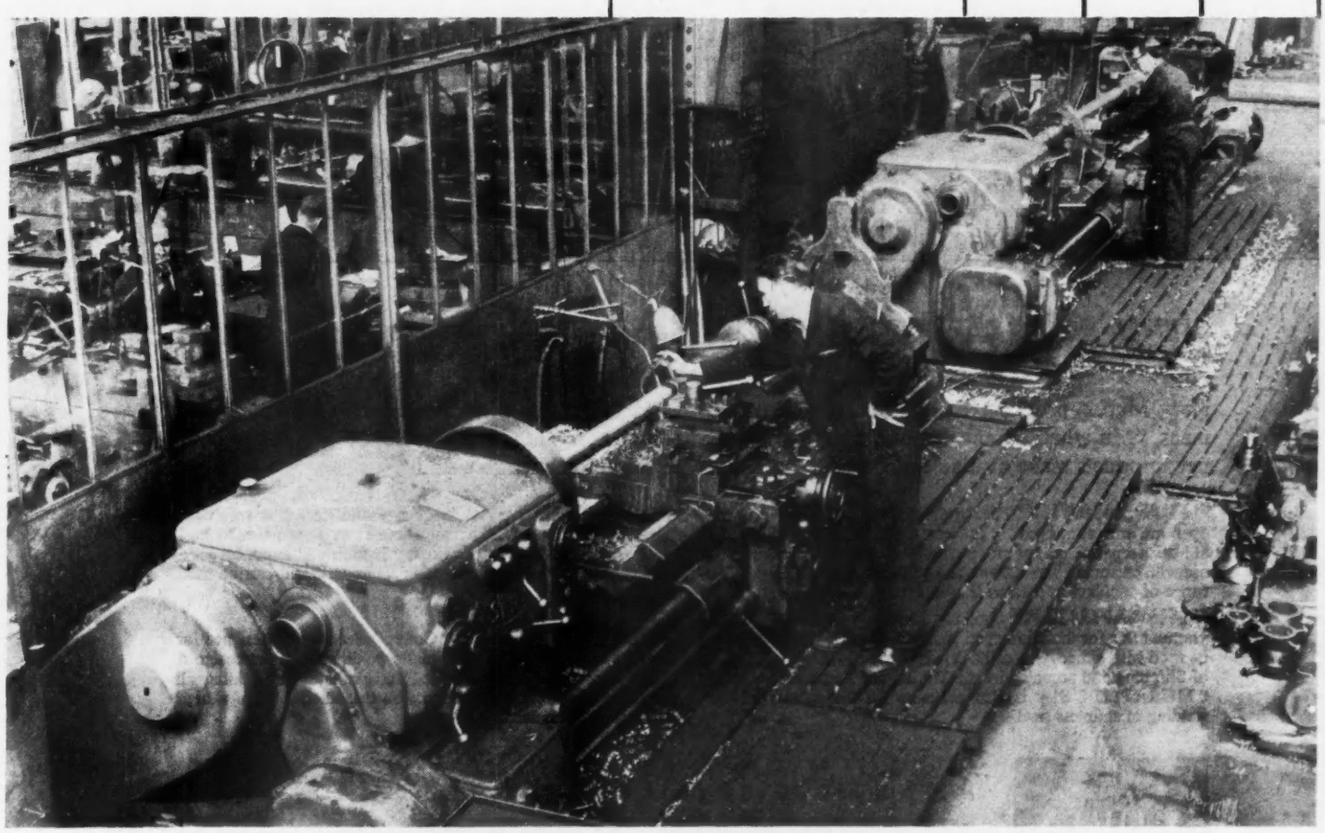

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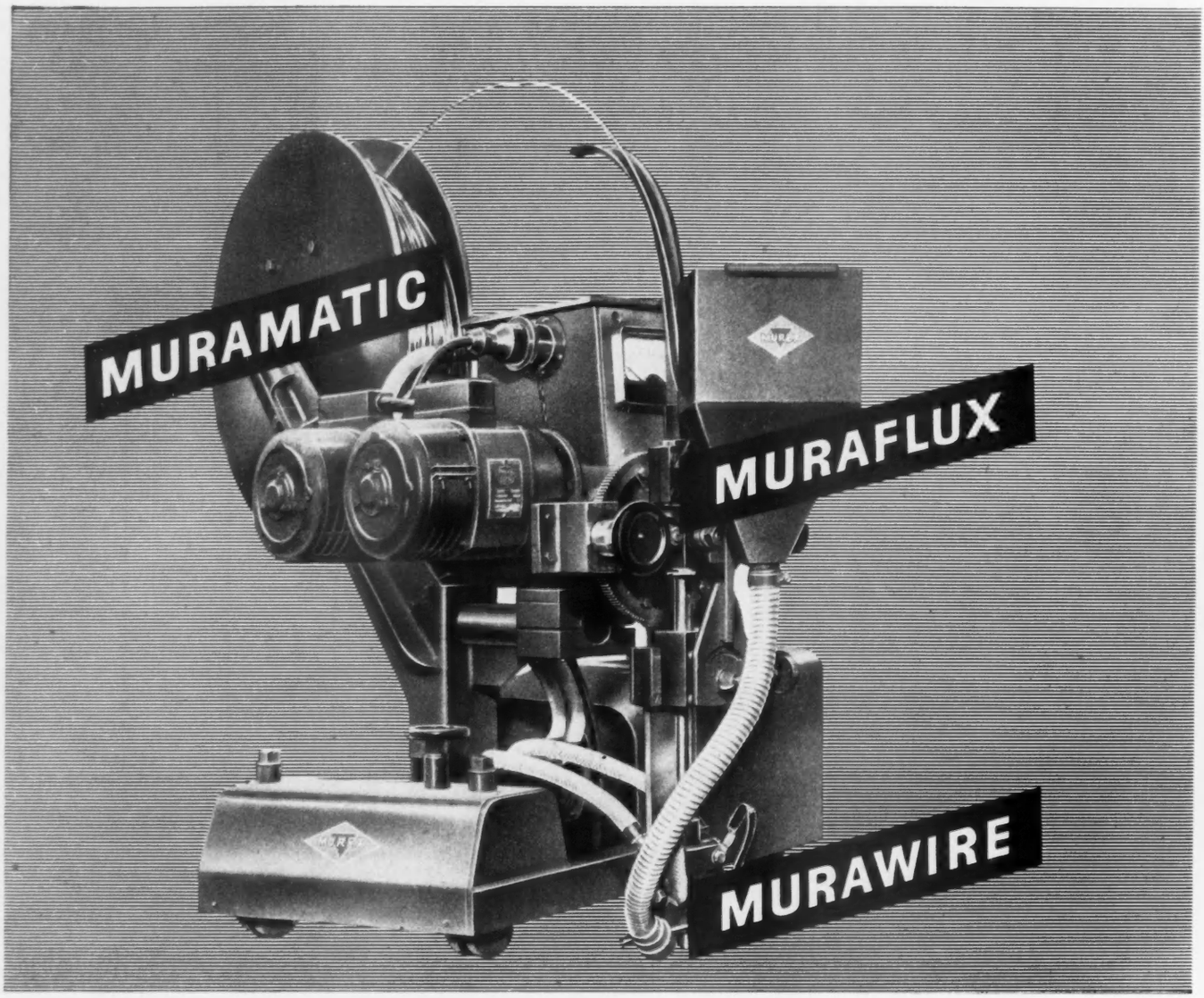

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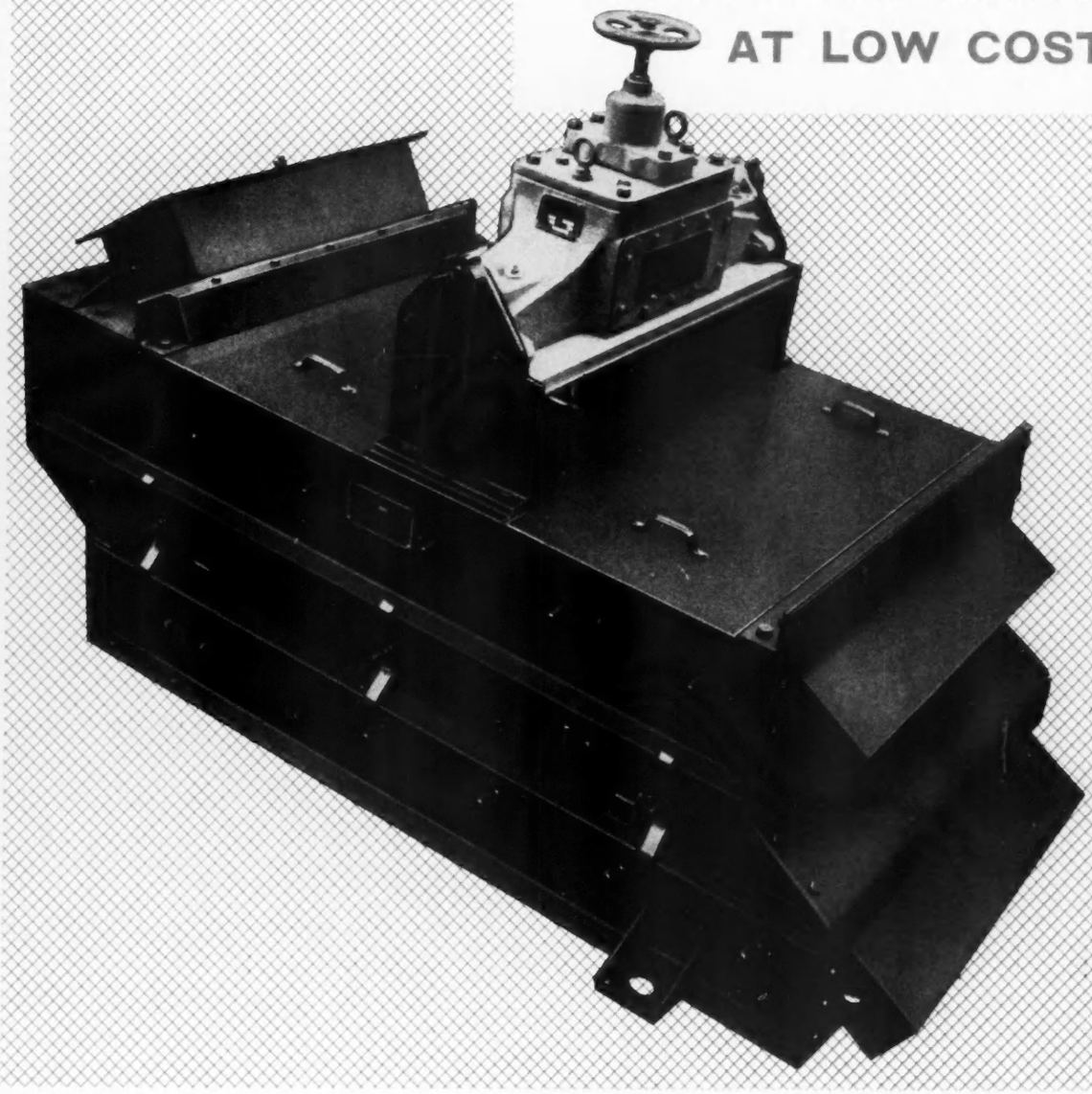

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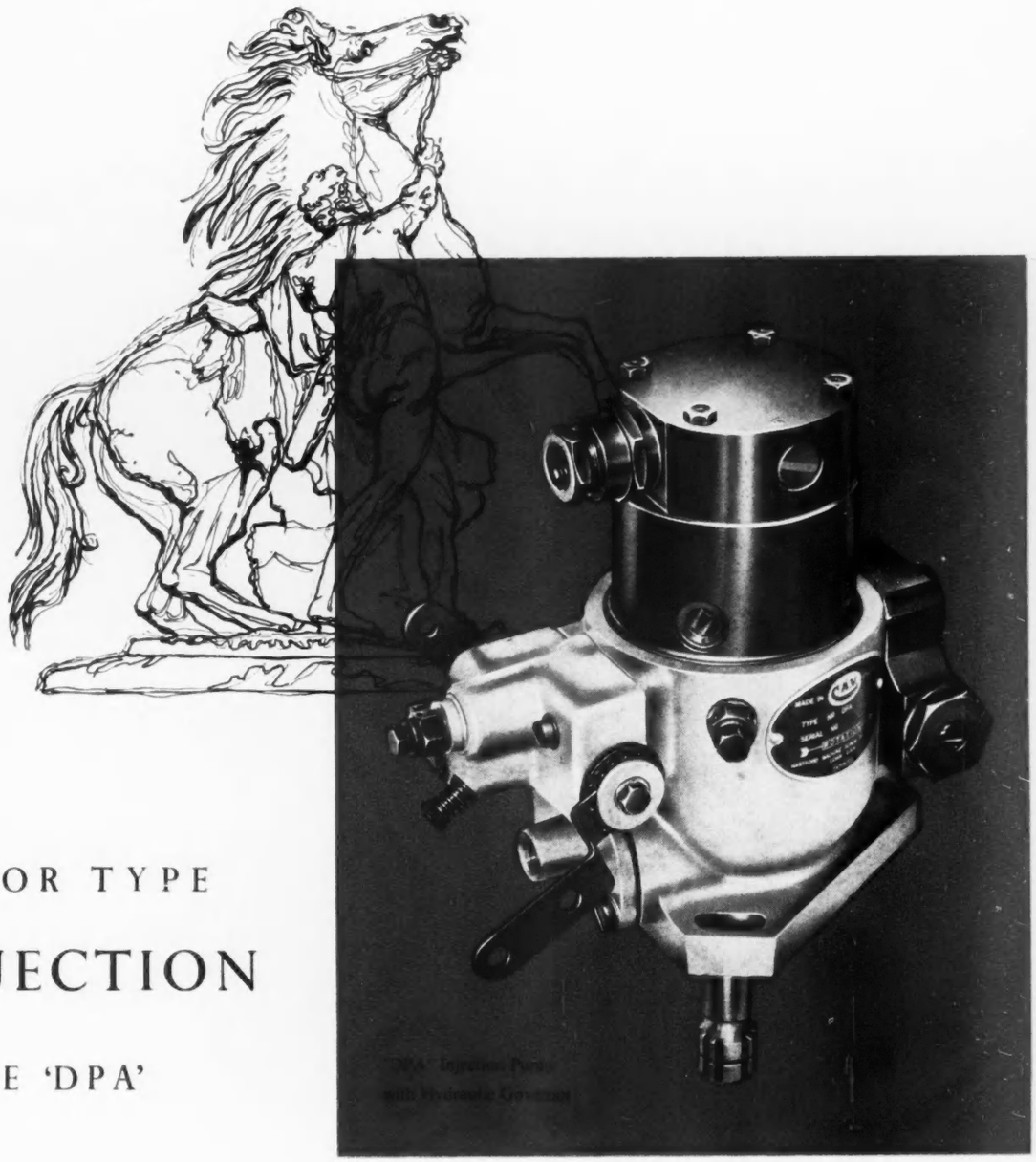

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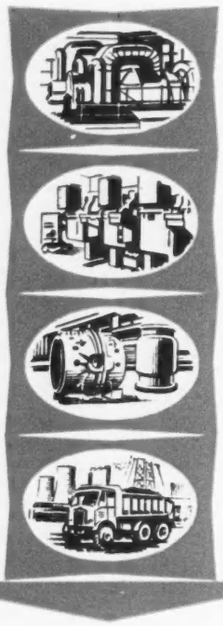

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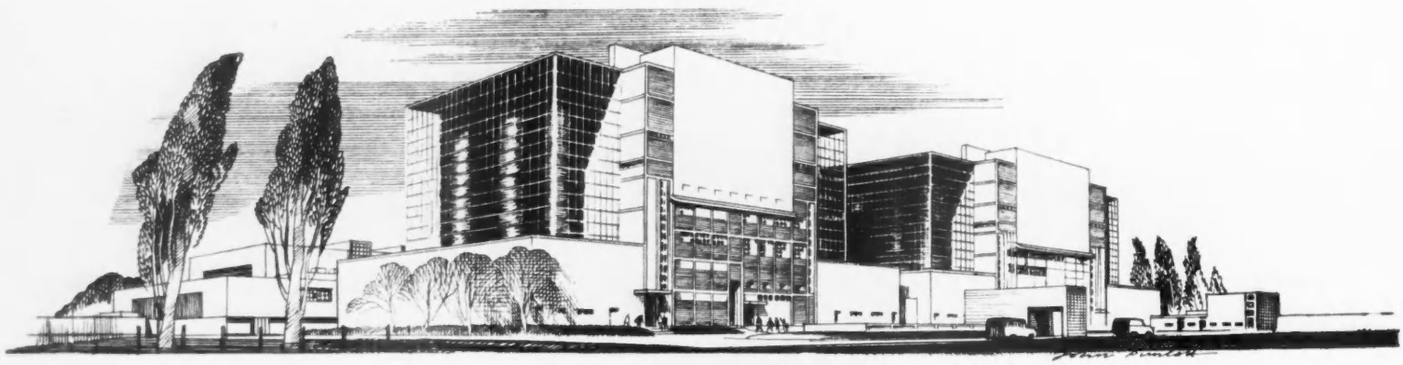

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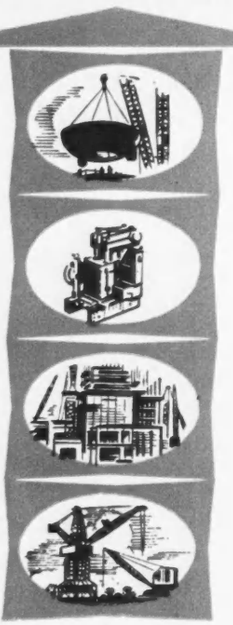

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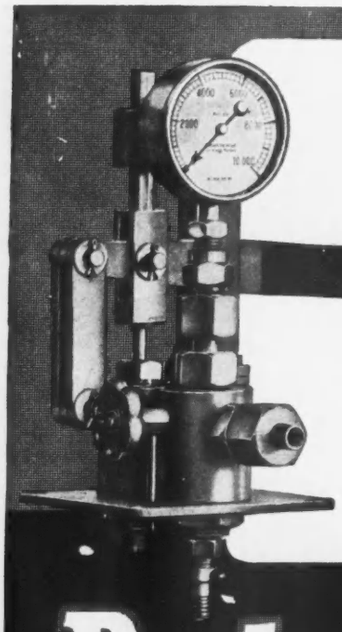

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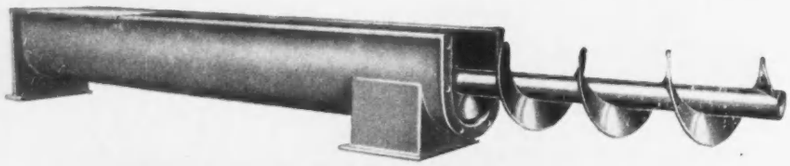

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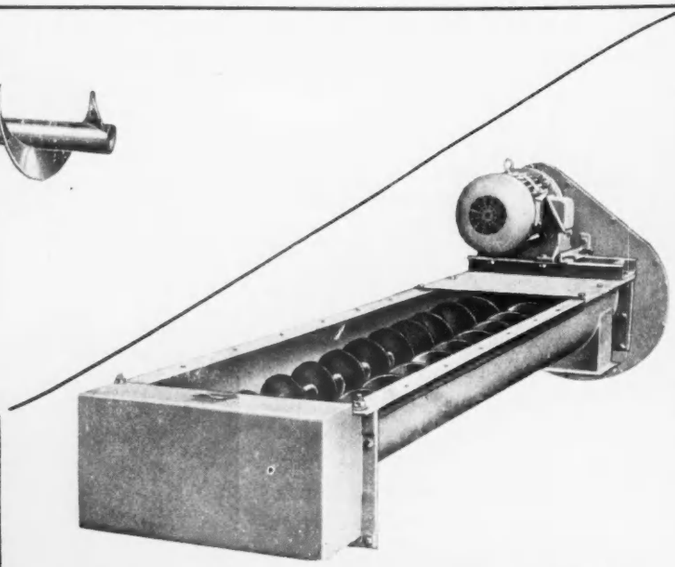

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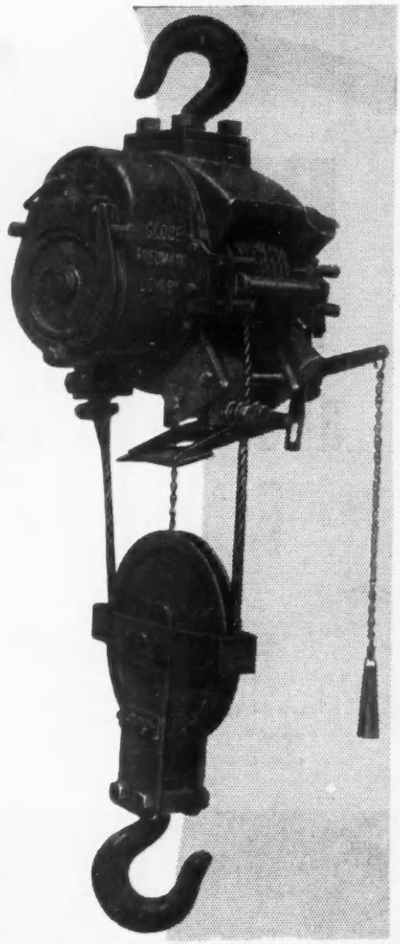

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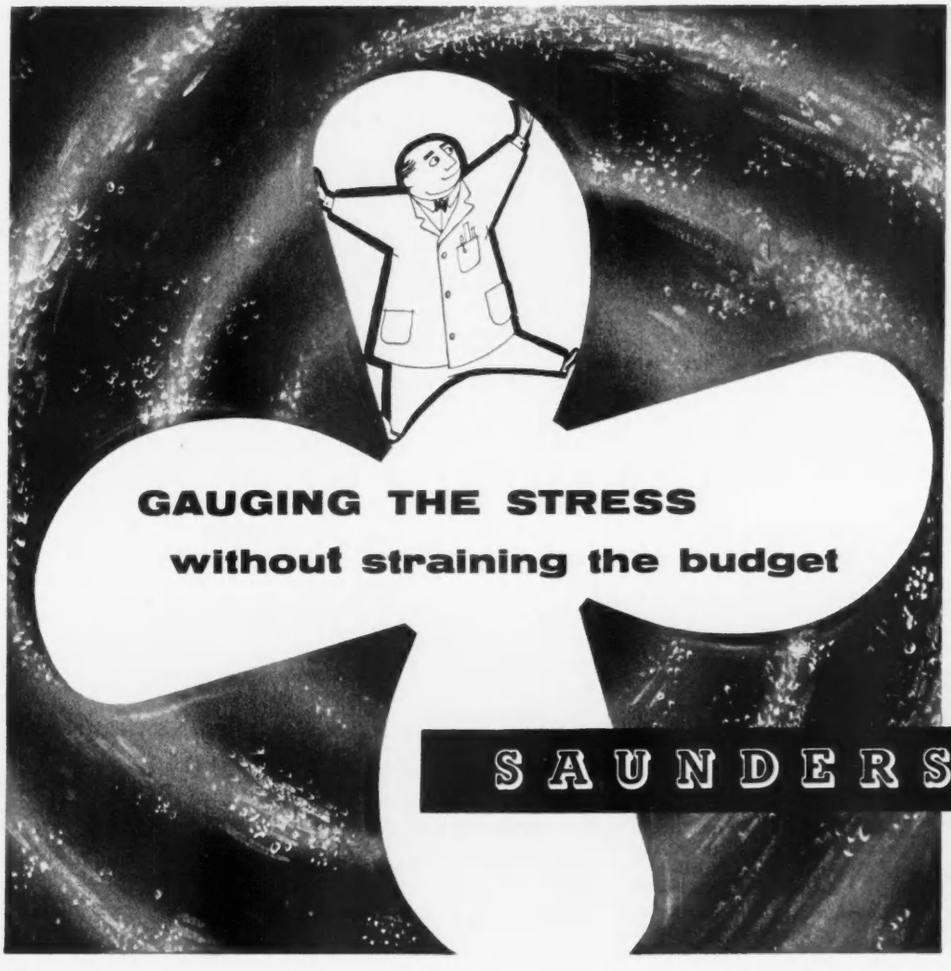

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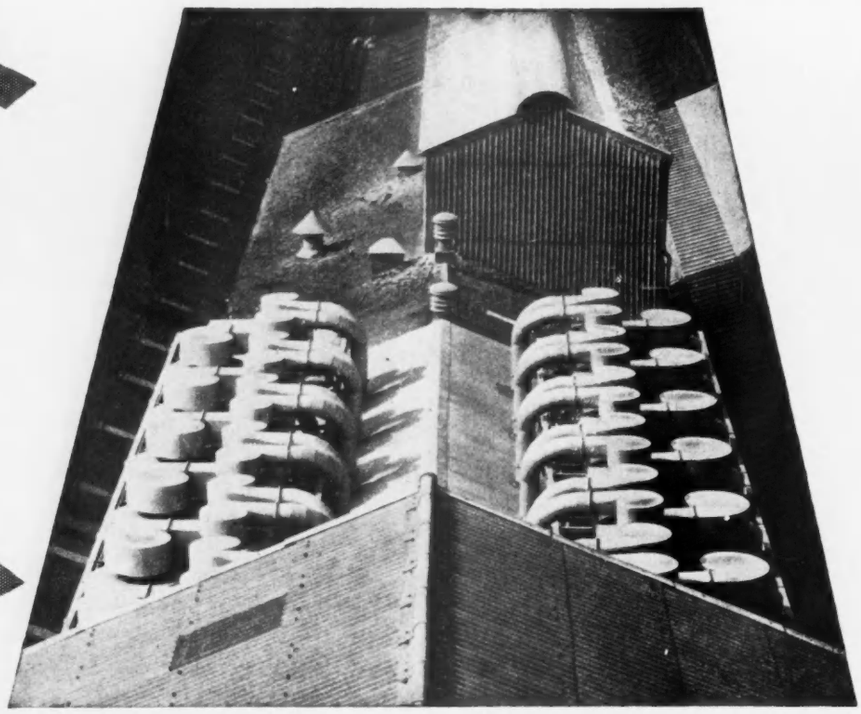

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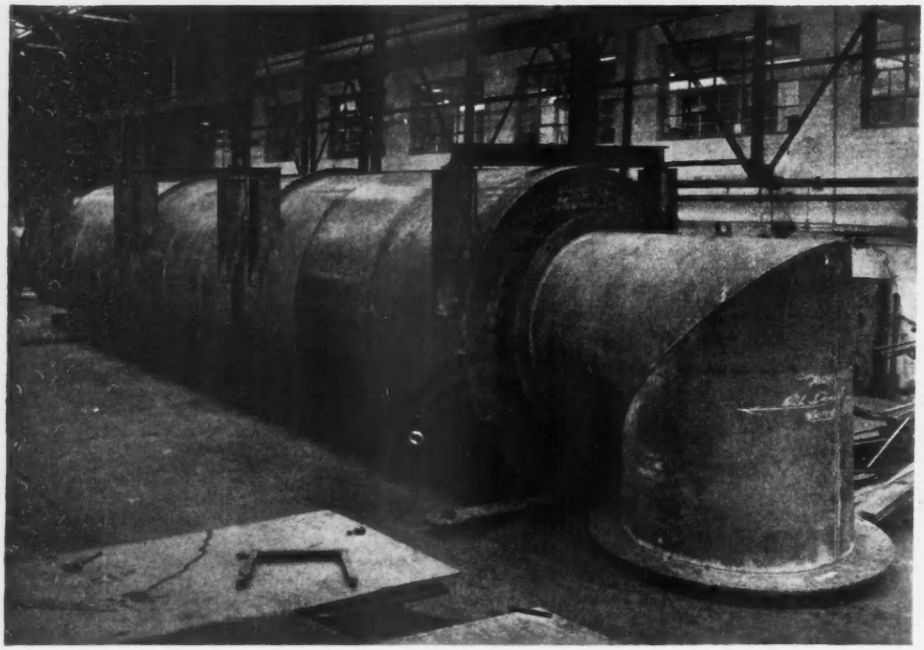

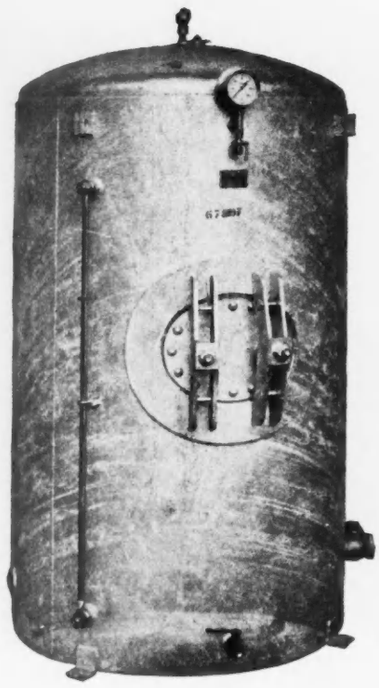

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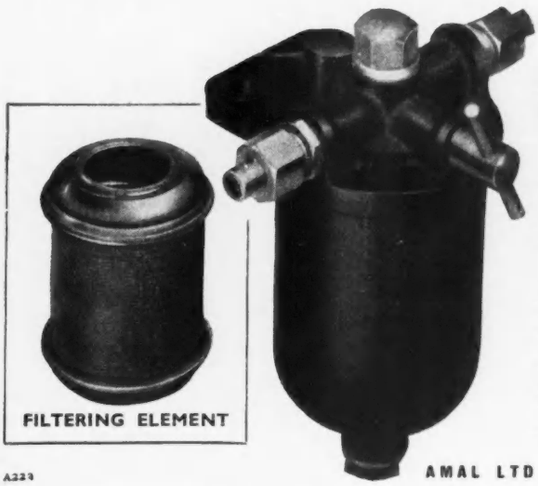

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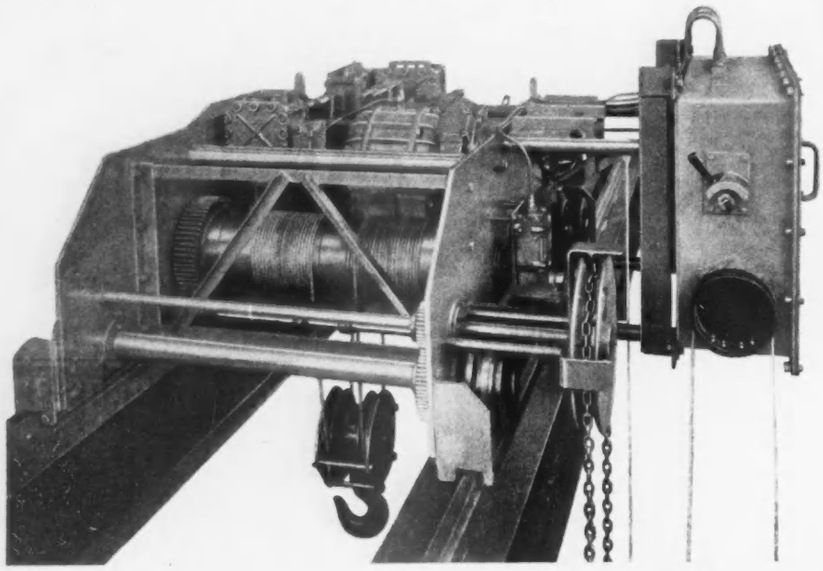

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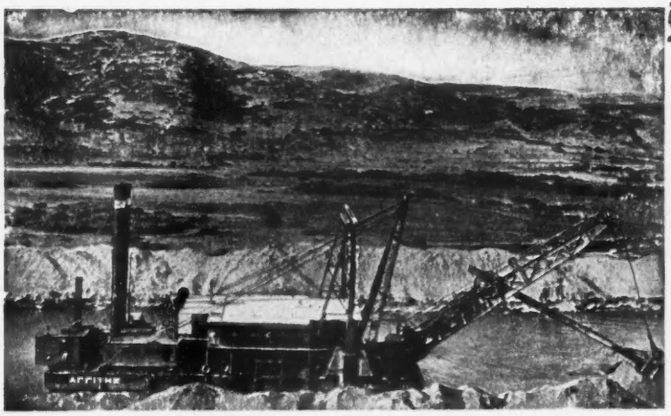

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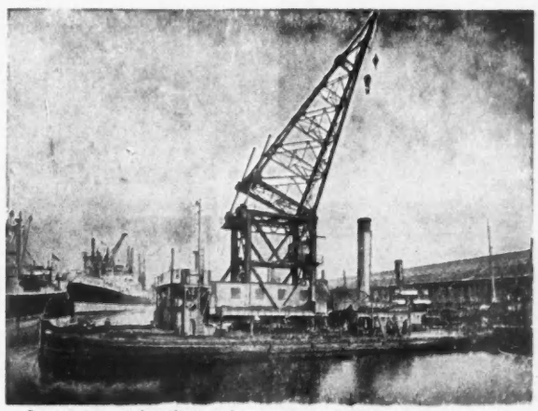

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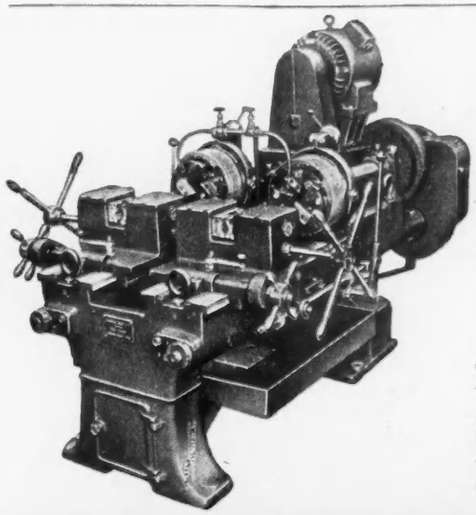

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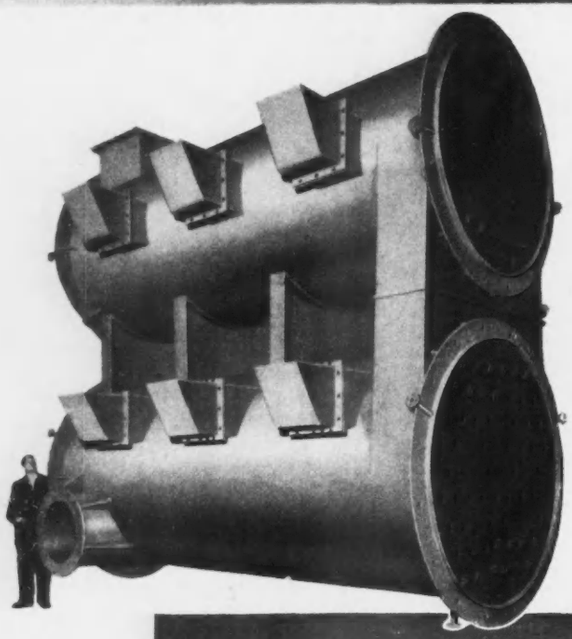

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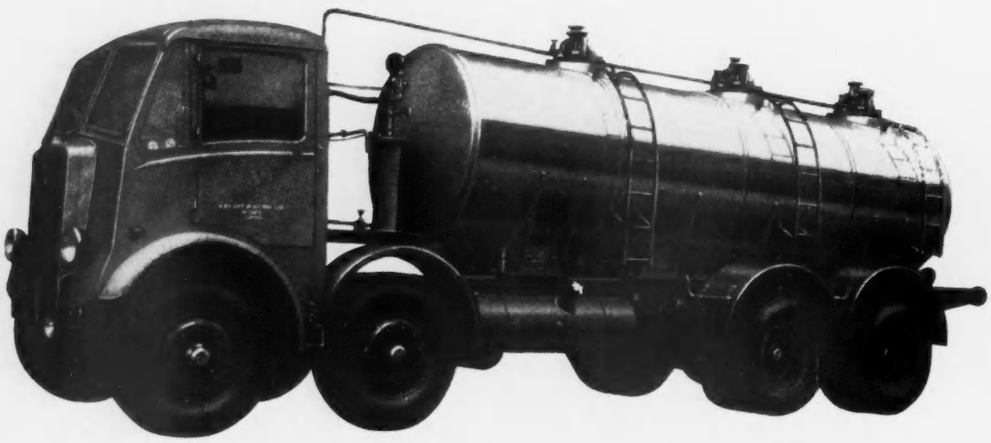
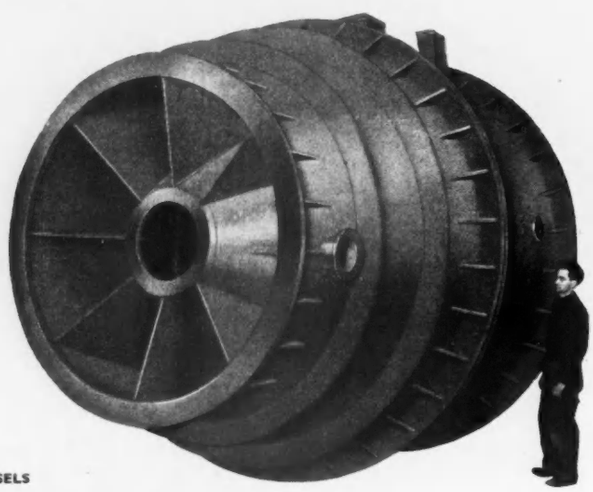


(Top) Mild steel casing, consisting of two shells; overall dimensions 17′ 6″ long, 9′ 3″ wide, 17′ 10″ high. (Centre) Aluminium jacketted stainless steel road tank for transporting phosphoric acid. (Right) ⅜″ Mild steel casing, weighing 4 tons, consisting of a cylinder and cone; diameter 9′ 7″ tapering to 6′ 2″ × 10′ 4½″ long.



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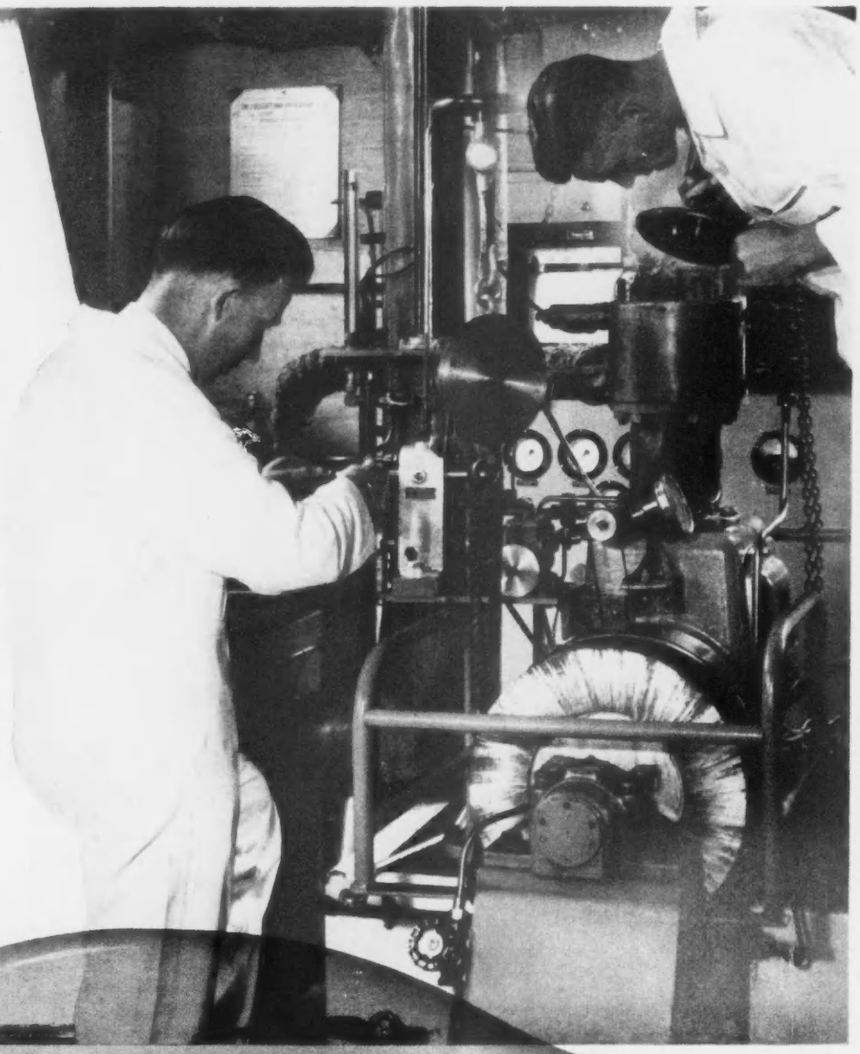

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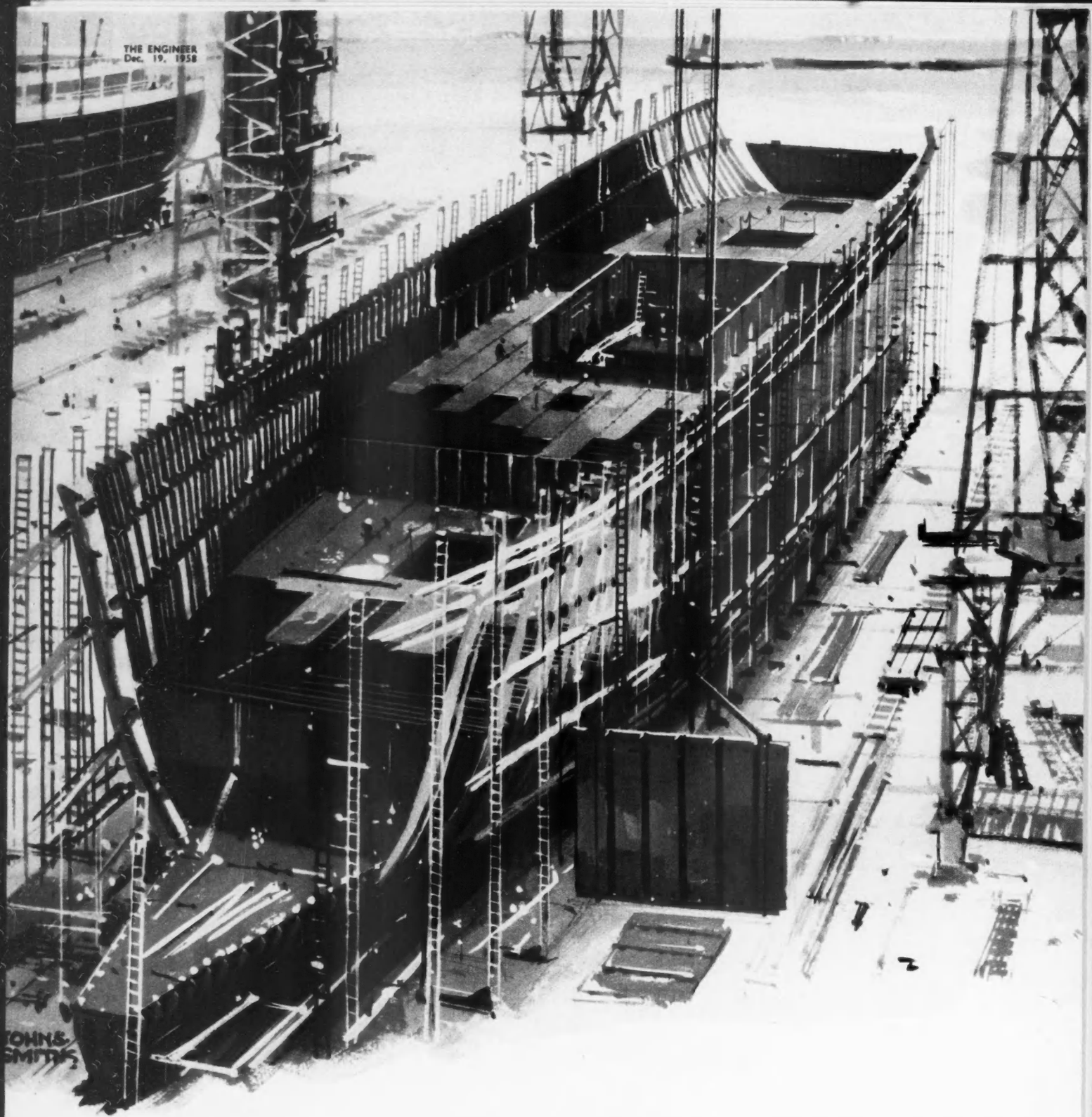

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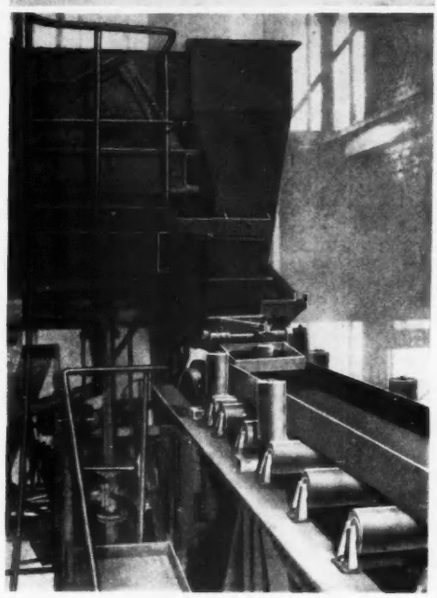

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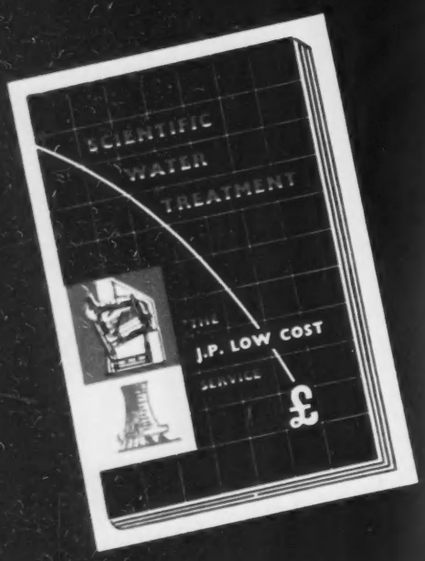

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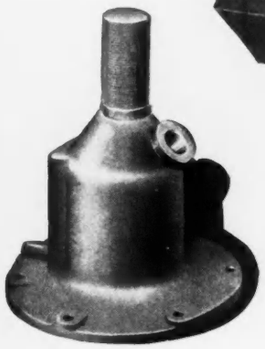

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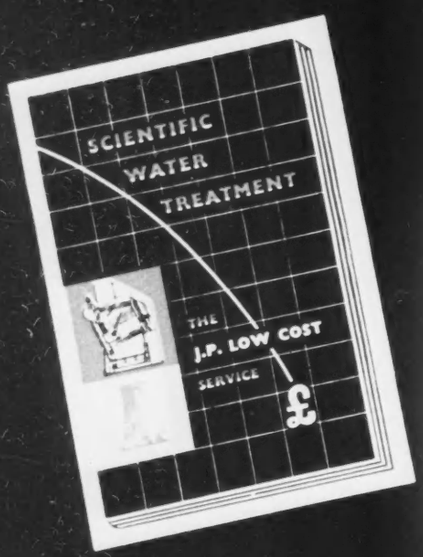

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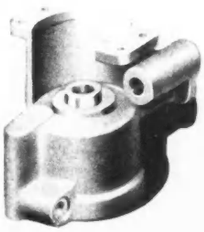

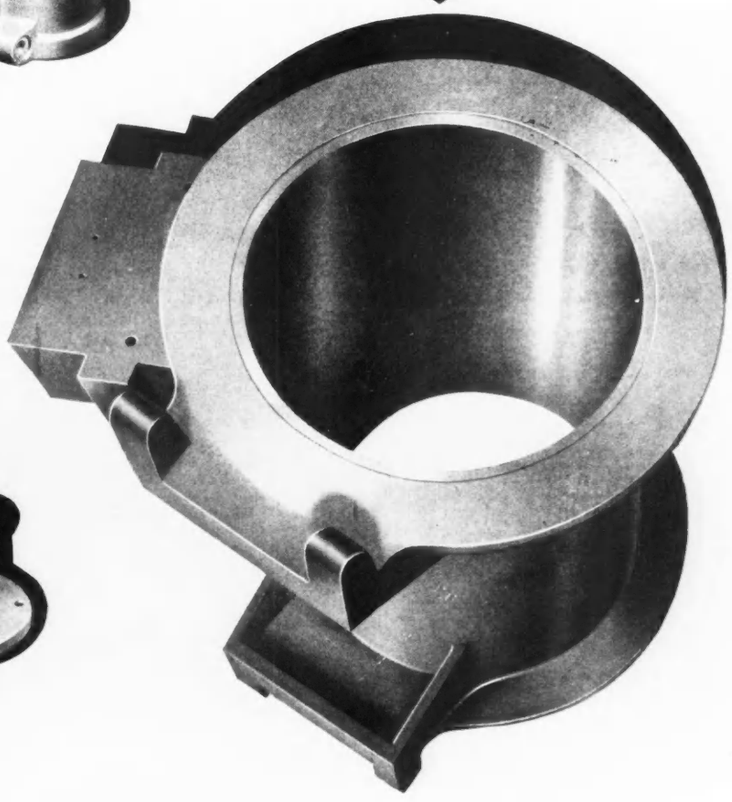

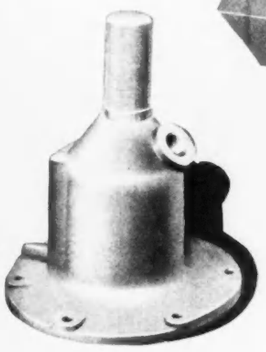

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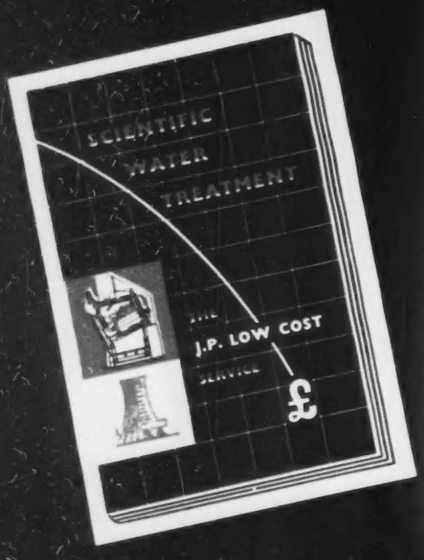

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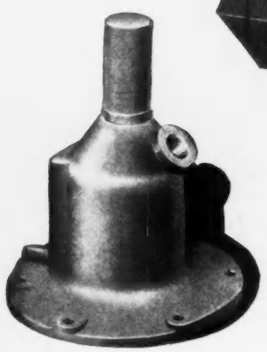

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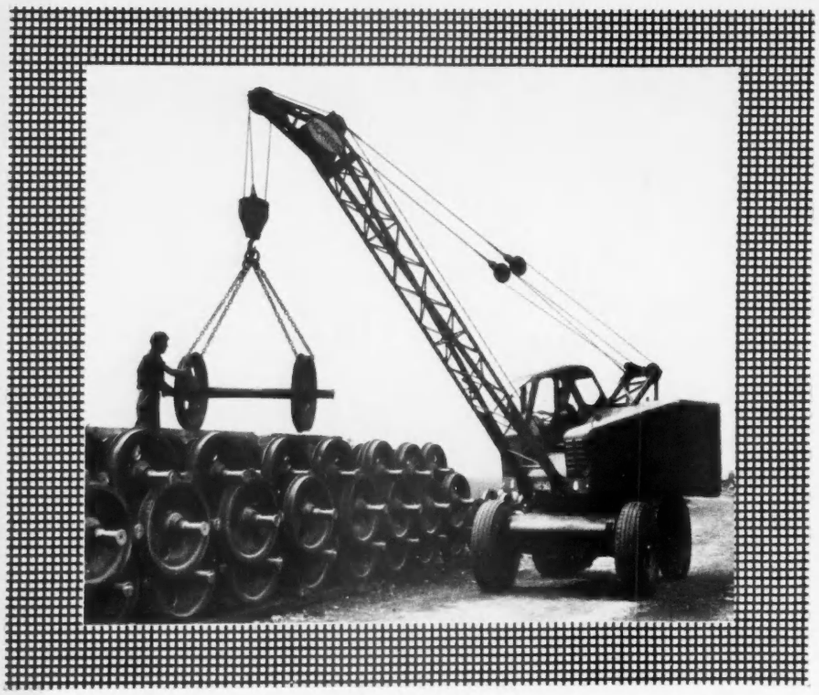

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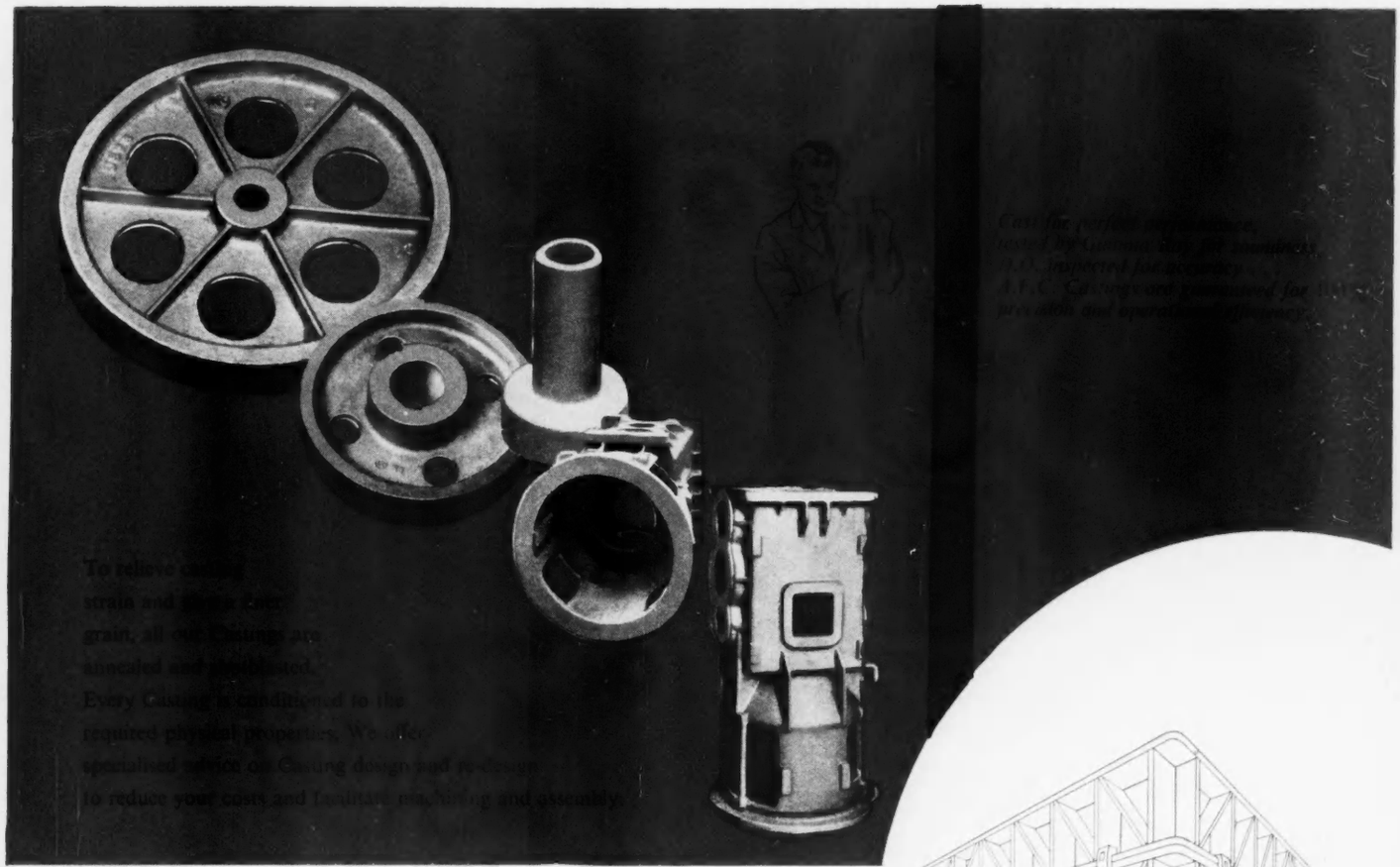

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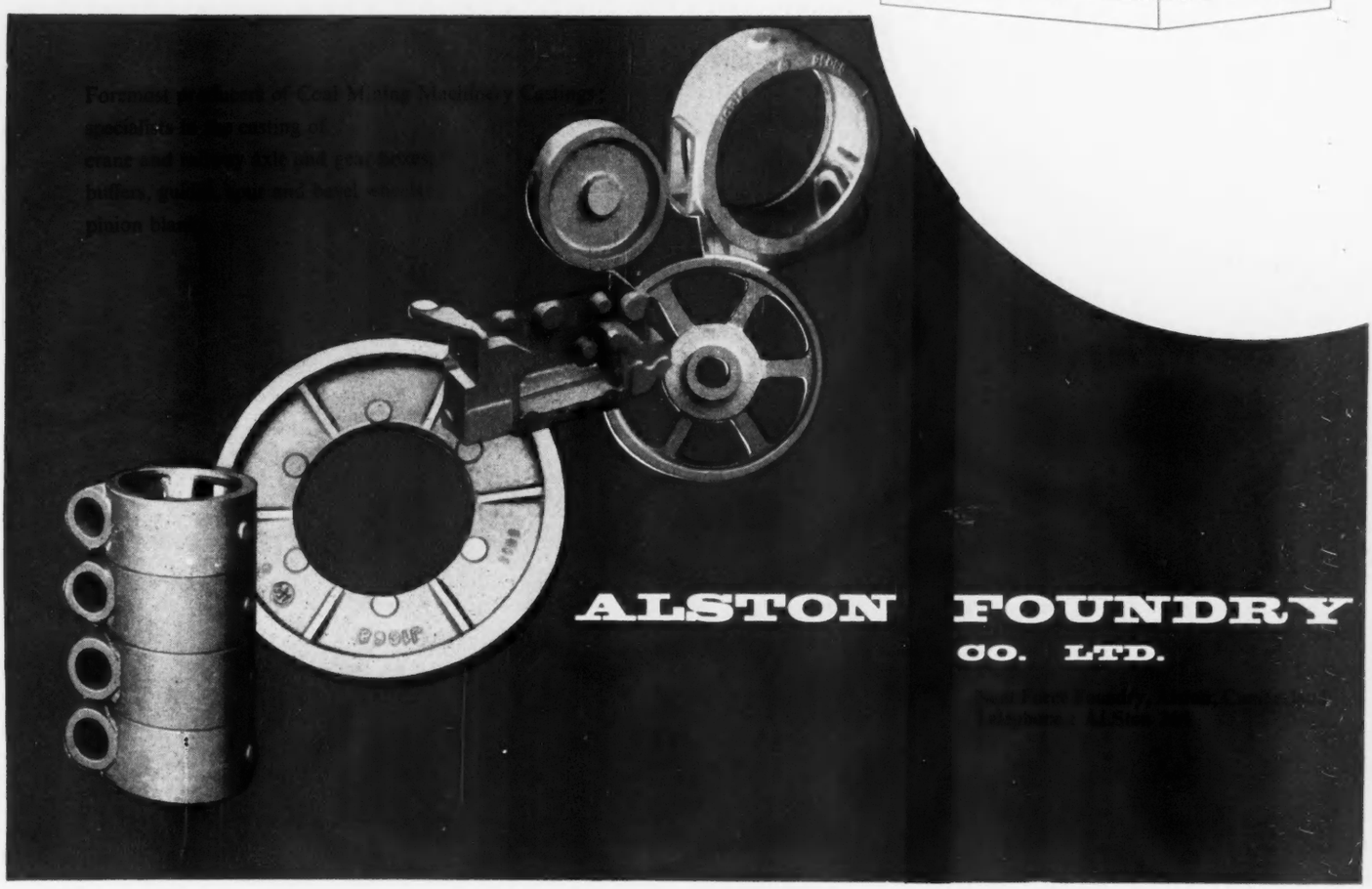

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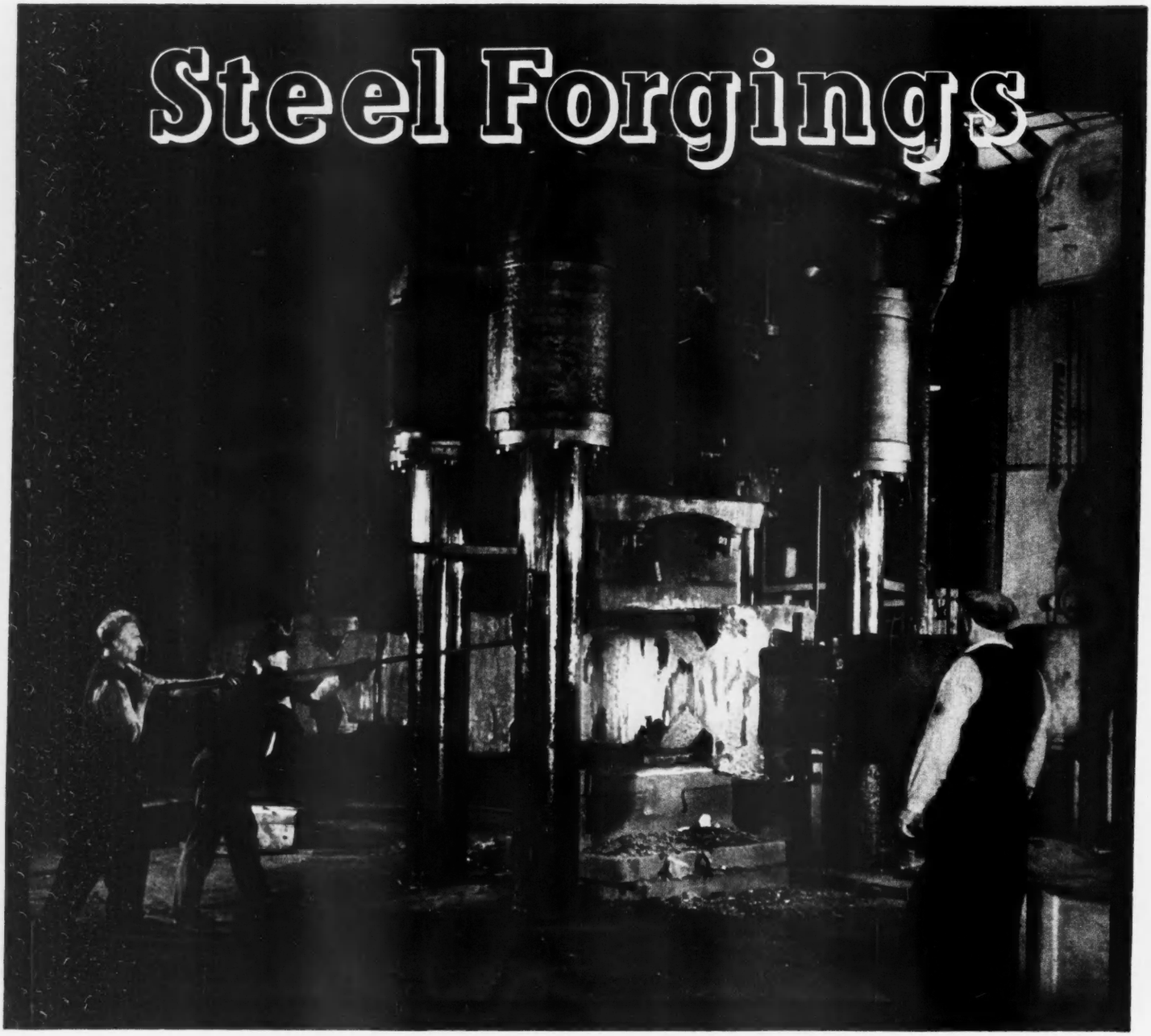

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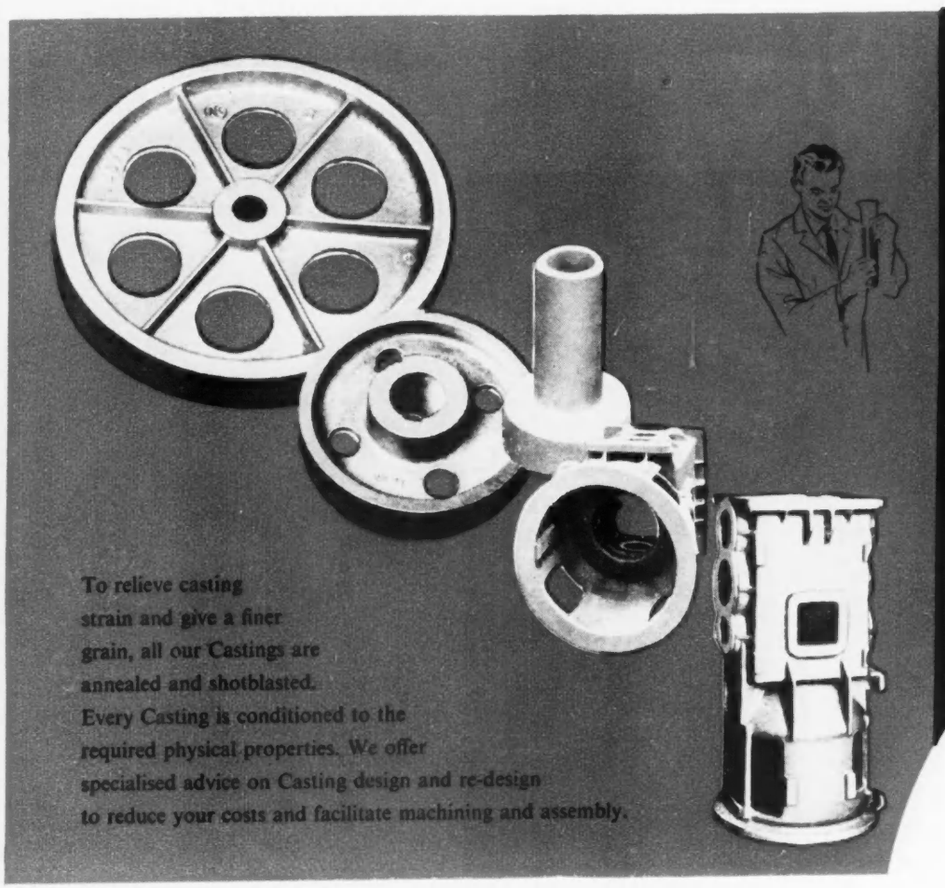

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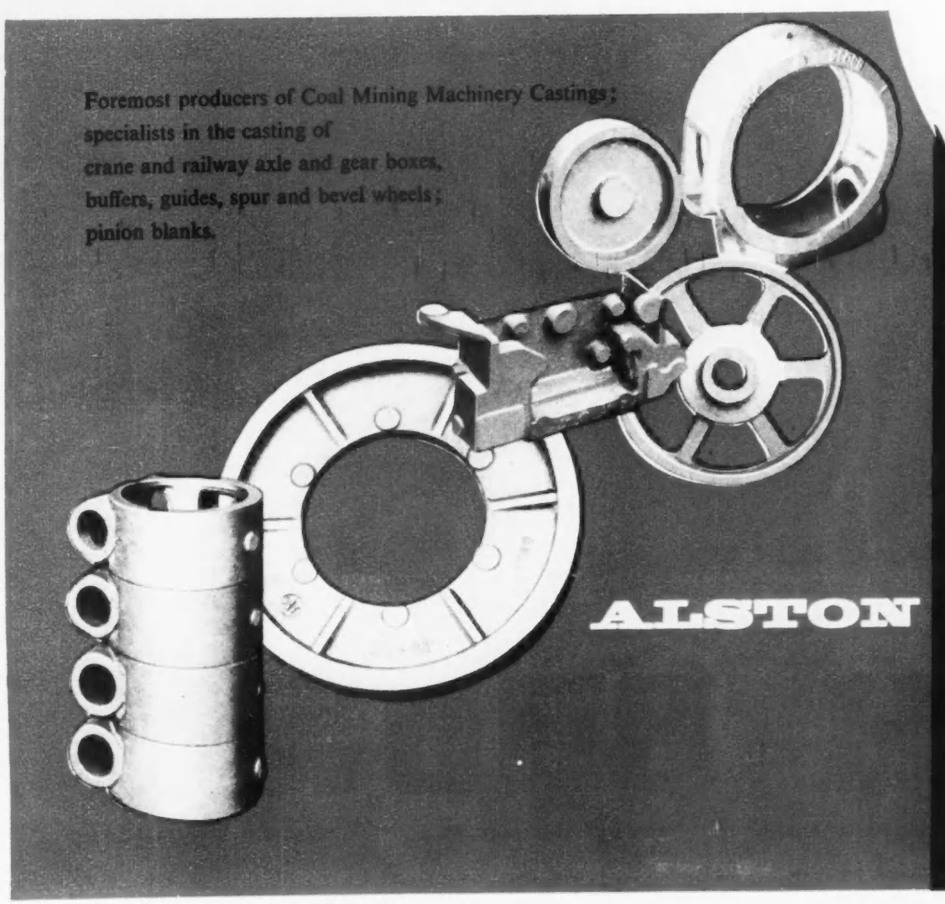

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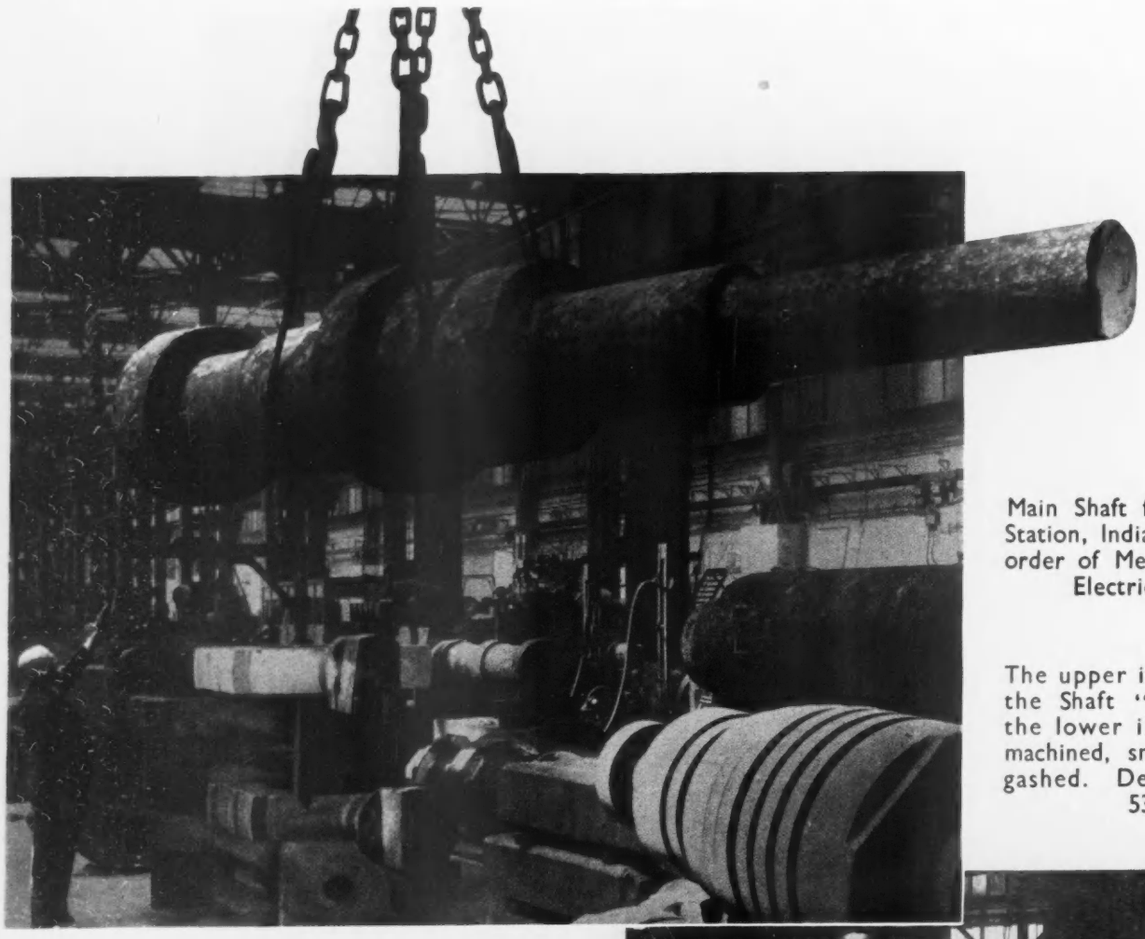
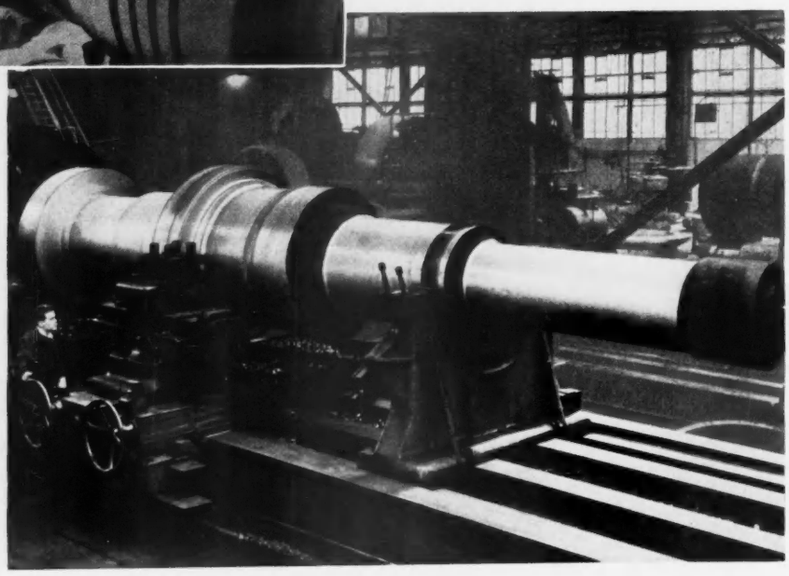


Main Shaft for Bhakra Power Station, India, supplied to the order of Metropolitan-Vickers Electrical Co. Ltd.

The upper illustration shows the Shaft "as forged" and the lower illustration rough machined, smooth bored, and gashed. Delivered weight—53½ tons.



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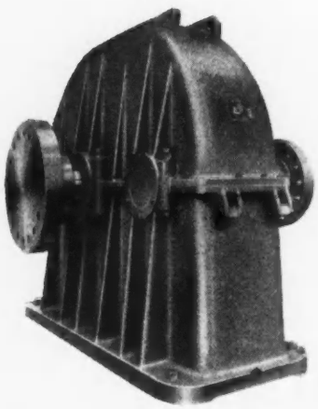

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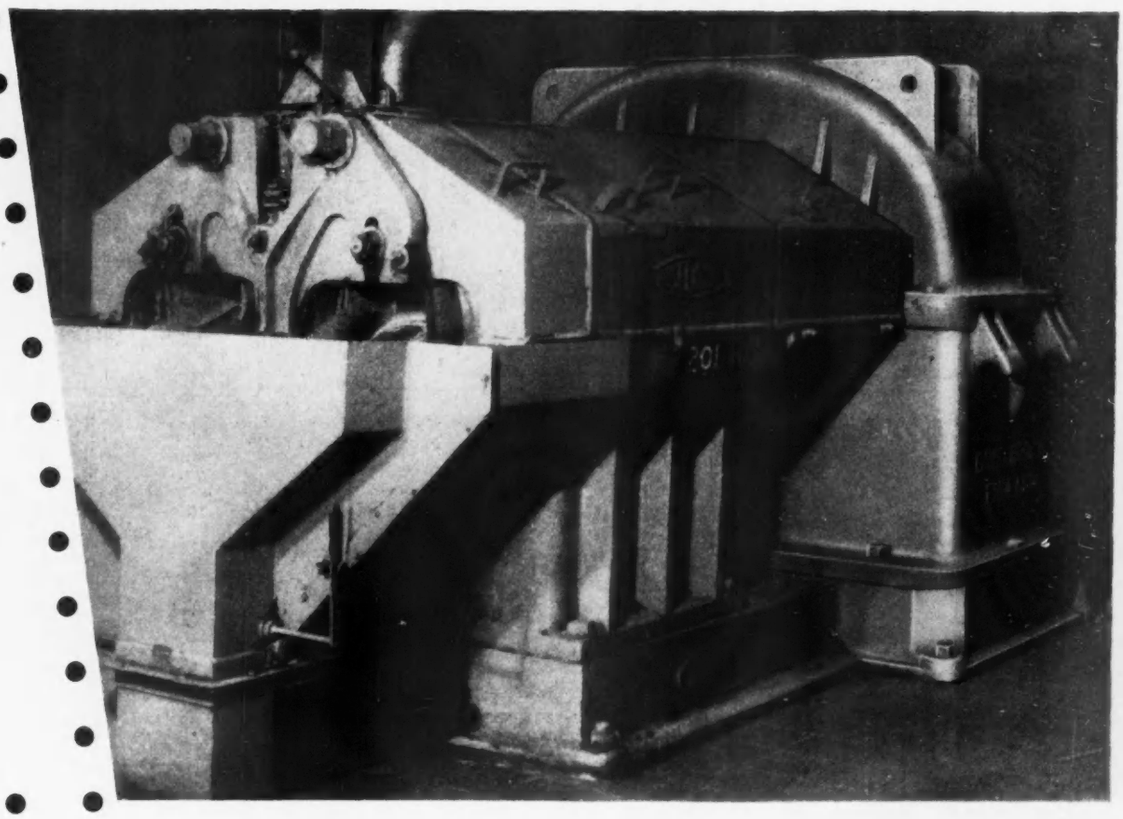

These Standard David Brown Helical Gear Units transmit continuously 80 h.p at 65 r.p.m. to cubing machines in feeding stuffs mill.
Photo by courtesy of Rose, Downs & Thompson Ltd. and The British Oil and Cake Mills Ltd.

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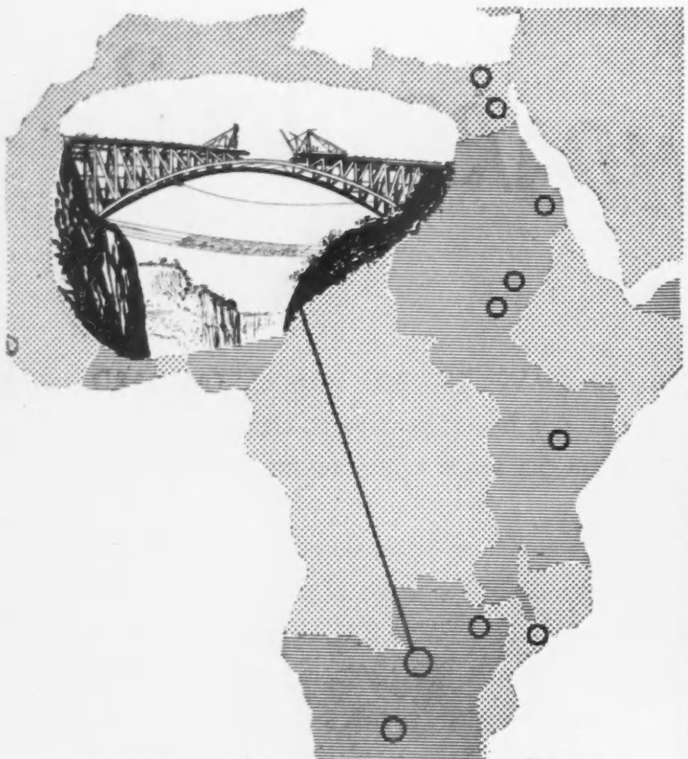

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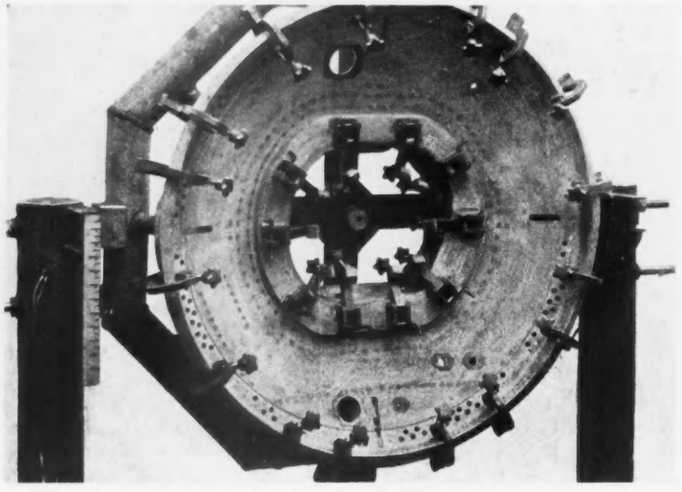

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'DOUBLE BOND' is a chemically-setting metallic plastic available either as a Putty or a Cream. It has a wide range of production and trade applications. 'DOUBLE BOND' can be used *both* for making objects in its own right *and* for sealing and joining, filling seams, channels, rivet and bolt dimples, etc.

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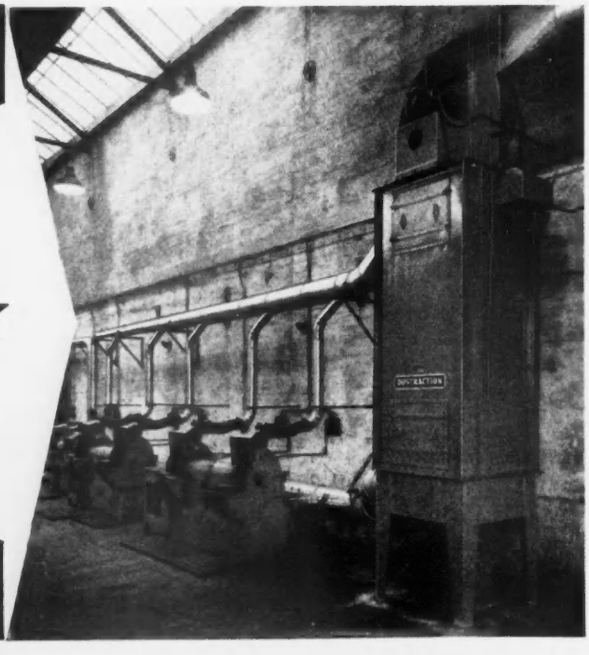

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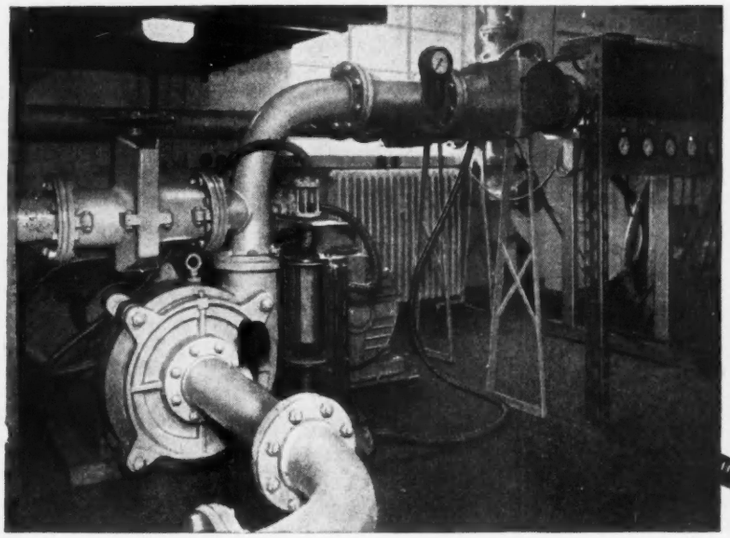

... but we can tell you that this plant is in a Research Establishment. And that a primary necessity in the plant was that the liquid and material in suspension should nowhere come into contact with metal surfaces.
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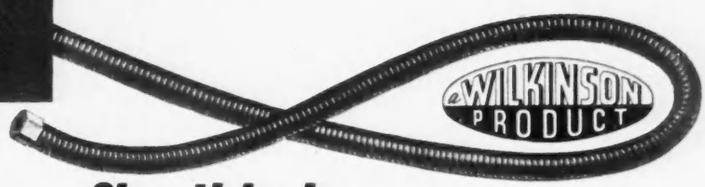
Suitable for all fluids or gases at temperatures not exceeding 50°C.



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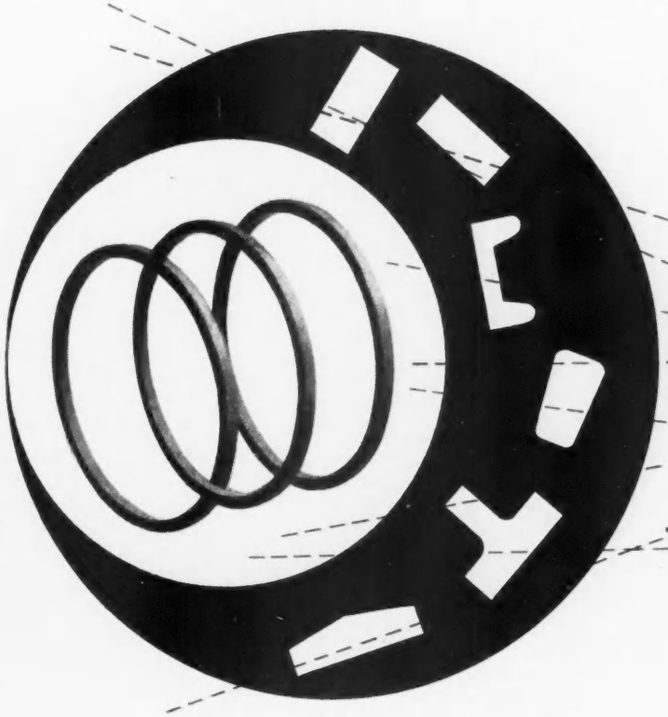

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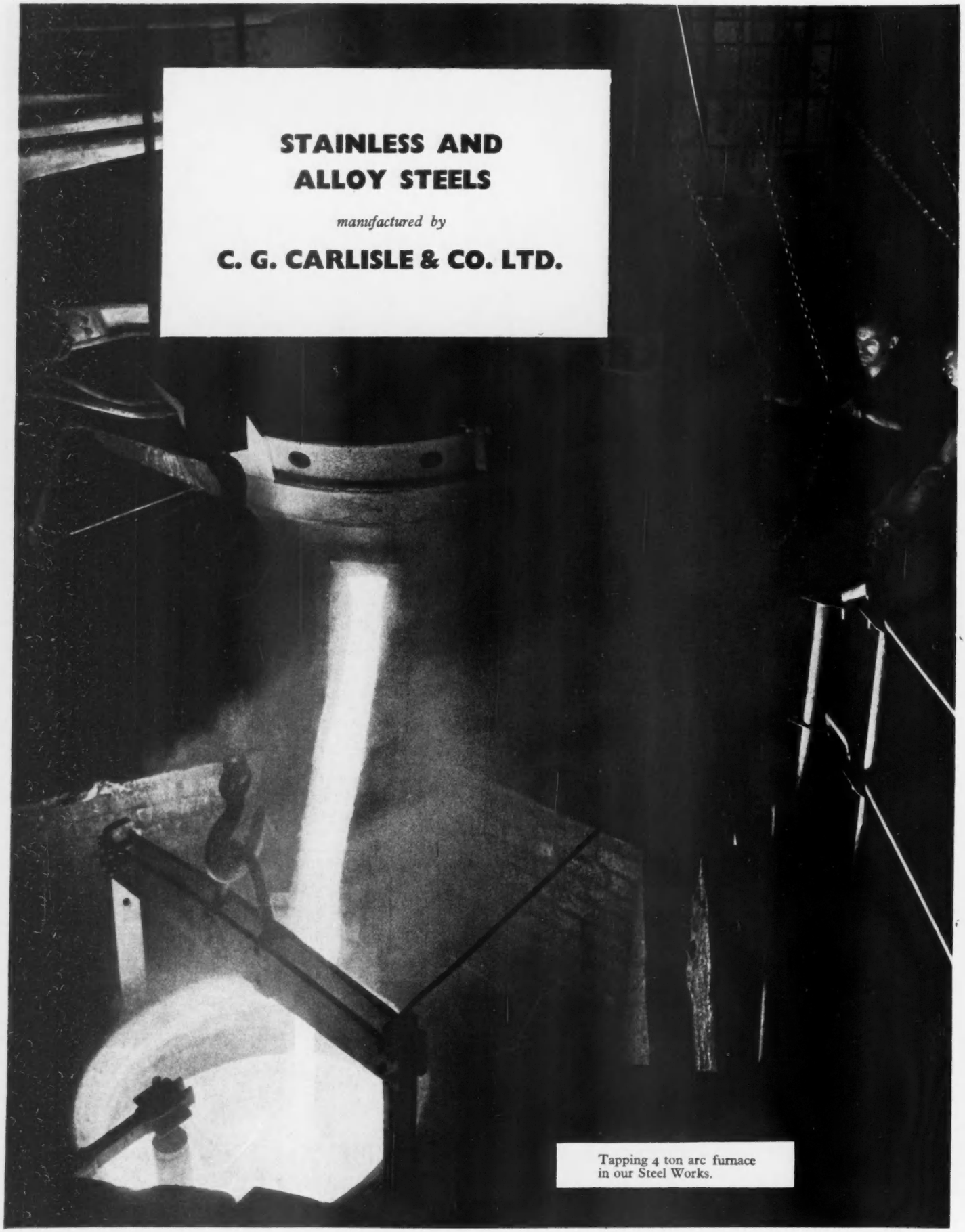

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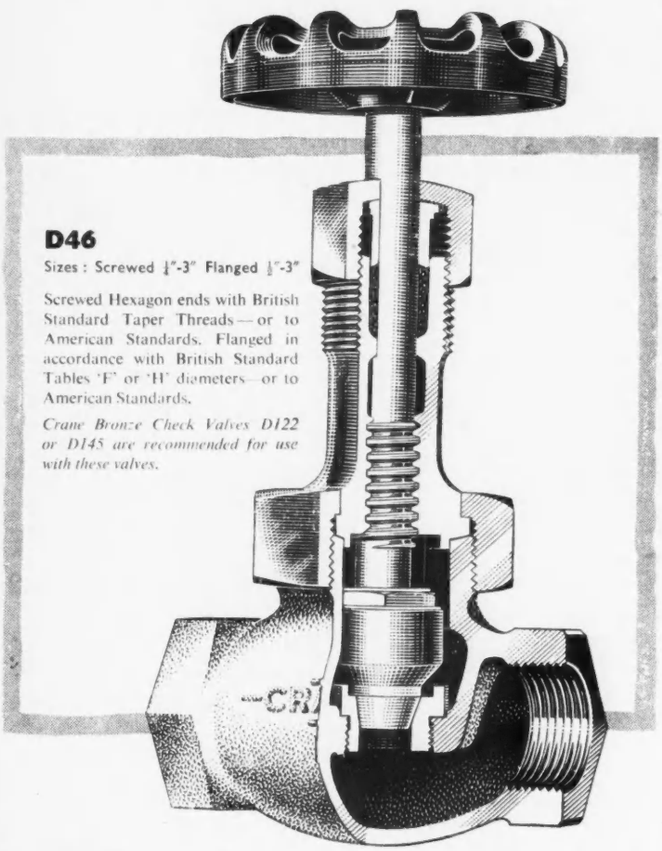

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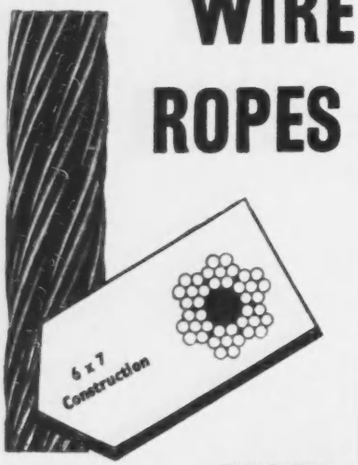

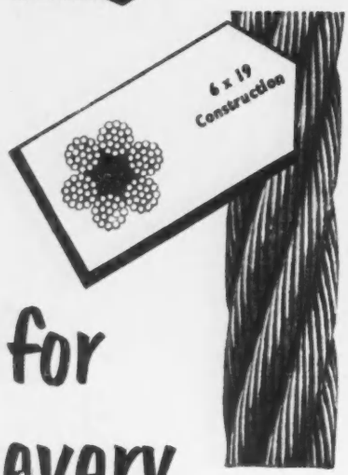

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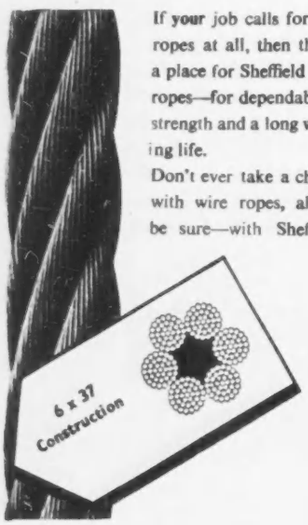

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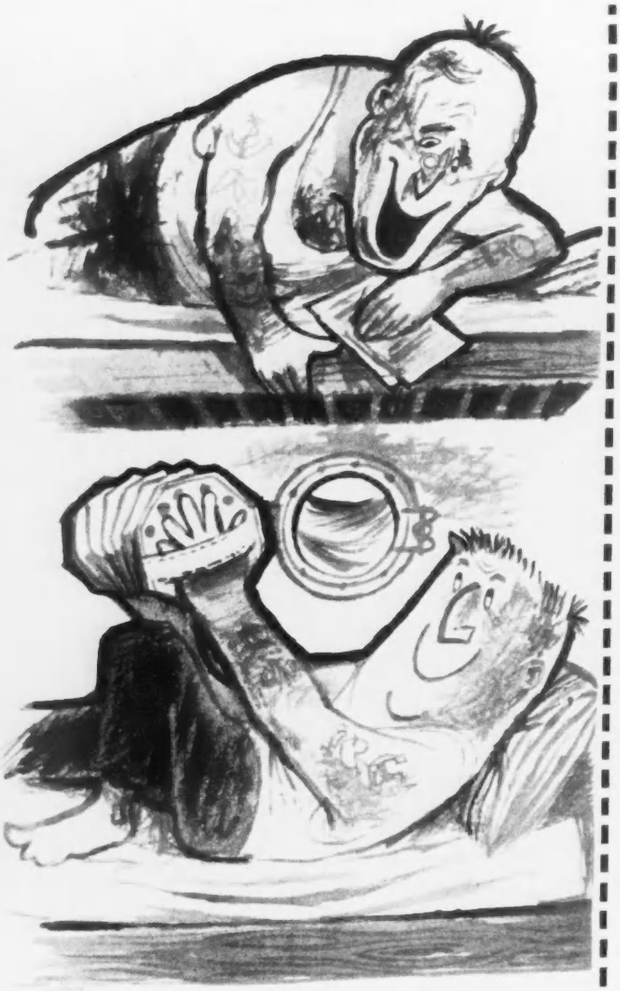

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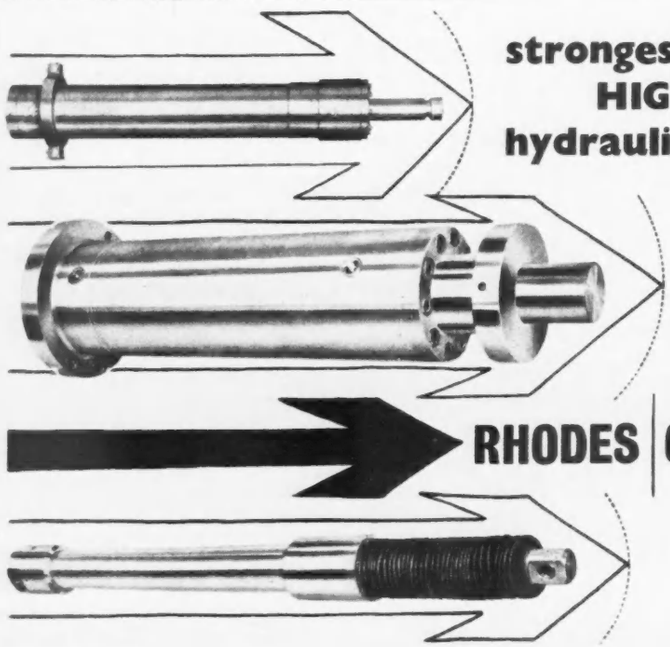

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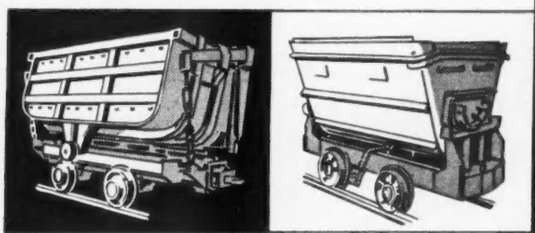

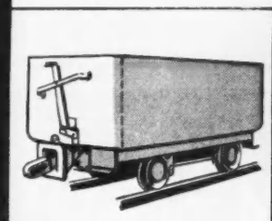

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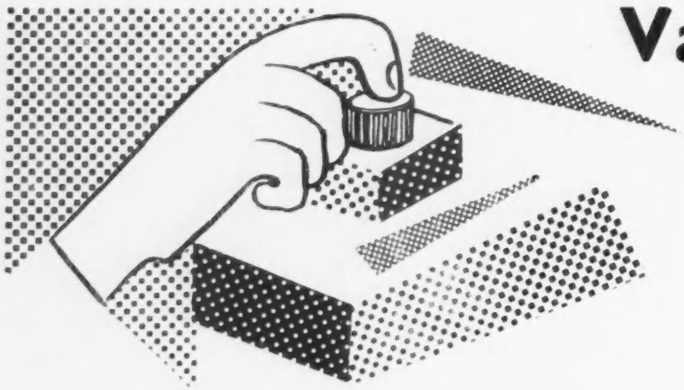

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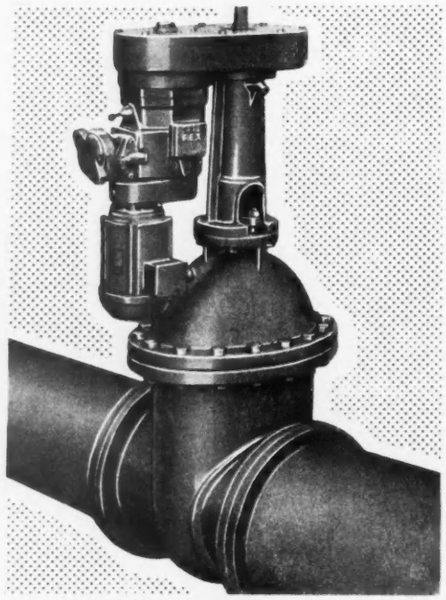

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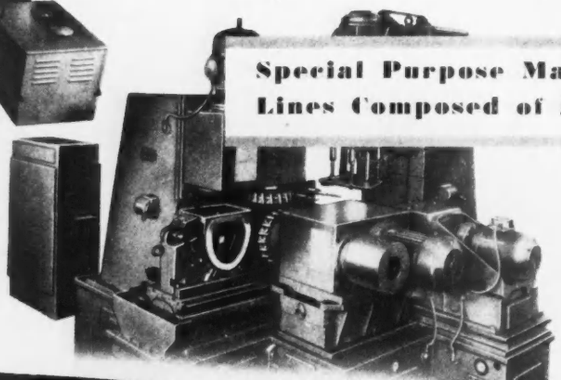

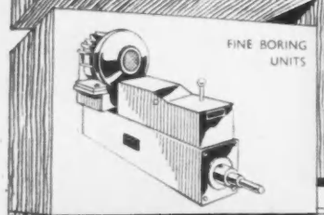

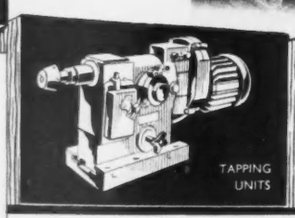

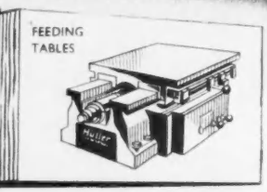

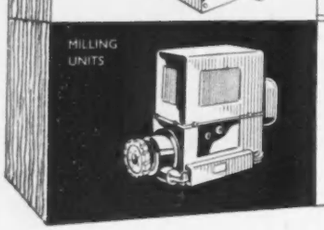

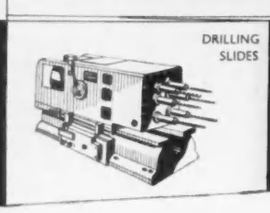

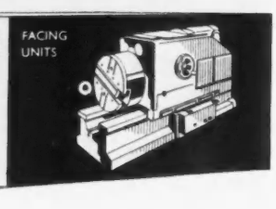

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THE ENGINEER

No. 5369 DECEMBER 19, 1958 VOL. 206

CLEAR THOUGHTS ABOUT RAILWAYS

On Thursday of last week, when commending the Transport (Borrowing Powers) Bill to the House of Commons for Second Reading, Mr. Watkinson mentioned that at his request the Transport Commission had initiated a detailed and urgent review of the whole Modernisation Plan for British Railways. So few years have passed since the Modernisation Plan was itself evolved that it seems at first glance odd that " a full detailed and urgent review " should already be needed. Indeed, some of the socialists in the debate attacked the Minister on this and other grounds for interfering unduly with the work of the Commission, and the need for a review which must throw an extra load of work on the Commission was questioned. But it must be doubted whether any significant extra load is being thrown upon the Commission at all. For it must surely be the habit of the Commission whilst investing large sums of money in the hope of improving its business to keep the situation constantly under review, just as a private concern would do. Moreover, it also seems to us that quite substantial changes have occurred since the Modernisation Plan was first conceived and that those changes ought to be reflected in the way the Plan is carried out.

Far the more notable change which has occurred since the Plan was conceived is that affecting the prospect of carrying coal. Again, it may well be that the iron and steel industry has been driven by events to re-assess upon more moderate lines the rate of expansion in the demand for iron and steel within at least the next decade or so. There needs, too, to be a recalculation, in the light of the extension of the nuclear power programme, of the amount of power station fuel which will need moving. But what is perhaps even more significant in its relationship to the amount of freight which the railways may be able to carry in the future is the degree to which the railways are reacting to their new powers to vary their charges. How boldly dare the railways move in that matter ? To what extent, by quoting particularly favourable rates for kinds of traffic well suited to rail carriage and unfavourable rates for unwanted traffics, will the railways in the nearer future be able to alter the picture of the kinds of traffic flowing along their metals ? To what extent, if such changes begin to come about, will plans for the building of new shunting yards, loading and unloading bays, &c., be influenced ? Will it become necessary to accelerate still further the rate at which wagons fitted with continuous brakes are being supplied to the railways ? The whole of the Plan, in so far as it is influenced by the freight side, needs constantly to be kept under review to take advantage of the developing situation, and it is satisfactory to know that the Federation of British Industries, the Association of Chambers of Commerce and the National Union of Manufacturers, representing customers, are entering upon discussions with the railways about these matters. In addition, the Commission—no doubt urged by the Government—strongly feels the need to bring its accounts into balance at the earliest possible date. Modification of the timing of the Plan may help it to do so as, for example, by pressing to a conclusion more rapidly than originally contemplated the L.M.S. route electrification from London to Manchester and Liverpool at the expense of greater delay elsewhere.

It is our belief, founded largely upon that of the Commission itself, that railways have still a large part to play in transport in this country, and that for certain limited purposes it should be possible to raise them to so high a state of efficiency that no other form of transport will be competitive with them. But that state of efficiency will be attained only if there is a ruthless acceptance of facts, unpalatable as well as palatable, combined with bold constructive thinking about them so that the railways concentrate upon doing what they can do superlatively well and do not attempt to compete where competition with road transport can never be economic. There is plenty of evidence that such ruthlessly clear thinking is being done within the Commission. Certainly that Commission has at its head a man fully accustomed to face unpalatable facts and to accept them as a challenge to ingenuity and execution. Yet we wish the propaganda department of the railways was imbued with the same spirit. It is nonsense, as we pointed out last week, to suggest that only two men are involved in moving a train load of freight and to claim thereby that no other technique can touch such figures of output for load transport.

We are surprised that Mr. Watkinson allowed himself to be taken in by it in the debate. It is equally nonsense to suggest that railways are ideally suited to carry bulk traffics when, in fact, substantial bulk traffics already travel by road ! We suggest that the public in this country and, no less important, railwaymen themselves, would have a greater faith in the future prosperity of the railways were the propaganda issued about them more in tune with reality. Bringing the railways up to a condition where they are really competitive for economic traffics with the roads and maintaining them in that condition as motorways extend across the country is going to demand toil, sweat and tears. Why not say so ? The fact is that quite a lot of people in this country have more than a sneaking suspicion that we could do without the railways. It is up to the railways to prove them wrong.

FINANCING ELECTRICITY SUPPLY

The Electricity Council has just published a booklet, *Power for the Future*, which contains some useful background information about the Electricity (Borrowing Powers) Bill, presented to the House of Commons last Tuesday. This booklet gives a brief outline of the development of electricity supply in England and Wales, offers an estimate of the growth in demand to be expected during the next few years, and indicates the cost of providing power to meet this demand up to the years 1964–65. There is no sign of approaching saturation in the use of electricity in industry, commerce, the public services or the

home. In industry, for example, efficiency of production is closely dependent upon the availability of increased horsepower per worker, and the latest estimates suggest that industrial sales of electricity are likely to increase by nearly two-thirds in the next seven years. A similar increase is forecast in the sale of electricity to domestic users. Sales to commercial consumers are expected to rise by 50 per cent and sales to farms are likely to be doubled. The public services are comparatively small users of electricity, but thanks mainly to the railway electrification schemes included in the Modernisation Plan of the British Transport Commission, consumption is expected to increase by 50 per cent in the next seven years. Summarising all the estimates, region by region, the electricity supply industry is, therefore, planning to satisfy a maximum demand of 29·5MW in the winter of 1964–65, compared with a present maximum demand of 20·8MW.

To meet this obligation the supply industry is programming for thirty-eight new power stations (including five nuclear stations and five new high-pressure installations), a considerable expansion of the grid and super-grid systems (including a cross-channel cable link), and, what is equally important, a much-needed reinforcement of the Area Boards' distribution networks. The cost of all these projects during the next seven years is likely to reach the formidable total of £2130 million. Of this total, £1030 million is to be sought from internal resources, including trading surpluses and provision for depreciation. The balance, £1100 million, is to be raised by borrowing and the necessary legislation is being introduced in the Electricity (Borrowing Powers) Bill.

The motive behind these wide borrowing powers and the prodigious capital expenditures envisaged should be clearly understood. It is to give this country the means to be strictly competitive as an industrial nation, so that it can earn for itself a higher standard of living. It will fail in this aim unless the closest vigilance is exercised to ensure that the maximum value is obtained for every pound of capital outlay. That is why it is essential to reduce the capital cost of fixed installations, power stations and of nuclear power stations in particular. That is why it is important to obtain the optimum usage of generating plant, transmission systems and distribution mains by a persistent encouragement of off-peak demand to improve the load factor. This form of activity has been sadly neglected in the past, and it is to be hoped that the electricity supply industry will devote a growing amount of its resources on the intensive promotion of load building with high load factor.

TRAINING FOR INDUSTRY

Some months ago, the Industrial Training Council was established under the chairmanship of Lord McCorquodale. The council consists of representatives of the British Employers' Confederation, the Trades Union Congress, the nationalised industries, the Ministry of Labour, the Ministry of Education, the Association of Technical Institutions, and the City and Guilds of London Institute. It originated from a recommendation made in the report of the Carr Committee on the Recruitment and Training of Young Workers in Industry. The principal objects of this council are "to keep under review the recruitment and training of workpeople, to provide encouragement and help to industries in dealing with the training of workpeople, and to collect and disseminate information about aspects of training common to more than one industry, including information about training practices in other countries."

Since its first meeting, in July, the Industrial Training Council has devoted a good deal of attention to the training problems presented by the coming "bulge" in the number of school leavers. Last week, the council held another meeting. It had before it a series of replies to a letter which had been sent to employers' organisations and trade unions urging that consideration should be given to the Carr Committee's report. According to an official statement following that meeting, there are "seventy employers' organisations, covering nearly two-thirds of all the manual workers employed in Great Britain, and a number of trade unions" which are now studying the report. On the other hand, there are some organisations which have said that "they are not considering the report." Most of these, the council remarks, represent small industries accounting for only a small percentage of the labour force. Obviously, for small industries and small industrial establishments the problems of training are more acute than they are for the large. There are, for example, numerous small firms in the engineering industry which together continue to make a notable contribution to the total product of that industry and to technical development of one kind or another. But upon many of them the reduced activity which has become apparent over the past year has pressed rather heavily. That may well be the reason why these small firms find themselves unable to give, at this moment, as much attention as they would like to the all-important matter of training more youngsters. There are training schemes, like the group apprenticeship scheme organised by the Engineering Industries Association, which are making steady progress, though there is scope for much more interest in them. The Industrial Training Council is undoubtedly approaching its task with zeal. In wishing it well, we would express the hope that, in addition to keeping under review the recruitment and training of workpeople, it will take whatever steps it can to provide encouragement and help to industry—and particularly to the smaller units of industry—concerning training problems.

WORKS RELATIONS

Executives in hundreds, if not indeed thousands, of smaller engineering firms will have read the report of the court of inquiry into the causes and circumstances of a dispute within the British Overseas Airways Corporation at London Airport last autumn with a certain degree of bewilderment. For how does it come about that the shop representatives of the men attain to a degree of power which is positively disruptive and which makes it doubtful which really is in control, management or men ? The picture revealed repeated, with variations and in less startlingly dramatic colours, that which the Briggs Motors inquiry painted ; and it may well be suspected that the troubles experienced on the South Bank site in London for the new Shell building are closely similar. Need the great mass of engineering firms fear that within their organisations similar troubles might arise ? Is it inherent in the evolution of trade union structure that shop stewards shall usurp powers that ought truly to belong to men higher up the union hierarchy? For our part we do not think there is anything very peculiar about what has occurred at London Airport, at Briggs Motors, and upon the Shell site. Nor we suggest has it much to do with trade union evolution. For even in the armed forces where strict discipline can be applied there are to be noted occasions when there has been a break-down in the relationships between officers and men. In the Navy, in particular, ships acquire reputations for being "happy"

or " not happy " according as to whether relations are good or bad. In civilian life where, under conditions of full employment, it is difficult to apply any more than the mildest of disciplinary penalties the art of maintaining happy works relations becomes all the more difficult to acquire. It is surprising not that there is sometimes more or less complete breakdown but that such breakdowns are so relatively infrequent.

There is a whole literature about works relations and Heaven forbid that we should attempt to sum it all up in a sentence here ! But there is perhaps one point which is worth stressing the more particularly as it can bring comfort to smaller firms. It is that by their behaviour amongst themselves and to their workpeople over everyday affairs the directors of a company can exert a really forceful influence upon the works relations of the firm concerned. We note again and again when we visit firms where relationships all the way up and down the scale are obviously good, how the manners are good too. To some extent—and providing the firm does not become too large—directors get the shop stewards they deserve. No firm can ever hope to be blessed with shop stewards who see absolutely eye to eye with the management. But courteous and considerate directors are likely to get stewards, militant maybe, but also capable of cheerful compromise. If relationships between management and men in any small firm are good to-day there is no reason to suppose that they may suddenly deteriorate. Quite the reverse in fact.

BEGINNINGS IN MEDICAL RESEARCH

It has become almost trite to remark upon the affinity between engineers and doctors. The human body is far more complex and far more difficult to understand than any machine. But it operates, as engineers' machines do, through the application of natural law. Thus, when doctors find a need to provide in some way for " spare parts " for the human body, the problems of their contributions are similar to those of designing spare parts for machines. The engineer and the surgeon think along parallel lines and can, indeed, collaborate with the greatest of ease and mutual understanding. Again, when the doctors desire, for their curative purpose and to assist the surgeon at his work, machines that can temporarily take over functions of parts of the human body, doctors and engineers need to collaborate and, in fact, easily do collaborate, in their design. In that way, amongst other devices, oxygen tents, breathing machines, and the heart and lung machine have been developed. Very possibly the future may see doctors and engineers collaborating on the design of machines capable of taking over temporarily the duties of kidneys, the liver, &c., whilst some operation is taking place on the living article. Will there ever be an artificial stomach, we wonder, capable of assimilating anything like as wide a range of foods as a real one ? By chance, the other day, we had the opportunity to see an early stage in what is possibly the development of such a machine and the device we saw might have come straight out of an engineering research laboratory ! All the apparatus was collected untidily upon a typical two-tier hospital trolley. On the lower stage were collected two jerricans and a Winchester quart bottle ; and on the top level was an untidy array of bits of glass tubing connected together by rubber tubes, screw-down clips taking the place of valves. In addition, there was a transparent plastic container partly full of a pale translucent fluid and a large brass cylinder with a handle on the top. A piece of spring steel was moved up and down (in some way which we failed to mark down exactly), and a pencil at its end could be brought into contact with paper wound round the brass drum and held in place by rubber bands. To record a result the pencil was applied to the paper and the drum rotated by hand. One could match the device in almost every engineering research laboratory in the land ; and wherever it was it would be presided over by a small group of enthusiasts entering upon early and exciting steps in what was likely to be a prolonged research.

We happened to see this queer device in use. The services of a patient were required to act as a guinea-pig and it says much for human nature (and latter-day faith in the medical profession) that to whatever Heath Robinson standards such a contraption may conform, there never seems to be any lack of volunteers in hospital wards. Moreover, this human courage is the more refreshing because the enthusiasts in charge of the device are likely to behave just as enthusiasts in charge of such devices do always behave. They are likely, having taken a reading, to stop proceedings for minutes at a time (to the apparent complete neglect of the patient !) to discuss, often with spirit and asperity, exactly what the reading means and precisely what went wrong ! The patient's reward—a cigarette, a bottle of beer or something equally inconsiderable—may not seem adequate payment for any discomfort suffered—we do not think the slightest risk is really incurred. Yet, in fact, is there not a much bigger reward ? Is it not something to contribute one's mite, even a passive guinea-piggy mite, towards the perfection of a device which may save thousands of lives or alleviate untold suffering in the future ?

The Engineer—100 Years Ago (DECEMBER 17, 1858)

" MONUMENT TO GEORGE STEPHENSON "

" The public is about to do justice to the memory of George Stephenson. His name, which few can speak with indifference—none with disrespect—is become historical—that of a great man whose semblance should be handed down in marble or in bronze, as a worthy memorial from the present to all future time. This, as probably all our readers know, is about to be done. The spirited determination, originating in the last meeting of the Institution of Mechanical Engineers at Newcastle, to erect a noble statue of the great railway engineer in his own native North, is being carried out in a worthy manner. For this purpose it was decided to raise £5,000, a large portion of which has been already secured in Northumberland, Durham, and Yorkshire, including handsome subscriptions from his Grace the Duke of Northumberland, and the Corporation of Newcastle.

" Although appropriately originating in the north and among those who best knew Mr. Stephenson while living, the suggestion for a statue should meet a hearty response in all parts of Great Britain, and we have no doubt that many engineers in the colonies would be glad also to contribute their share in the honour of a man to whose genius their profession will be for ever indebted. All that railways now are, together with the immense material development which has kept equal pace with them in all civilised countries, are the direct results of a system of engineering which, if Mr. Stephenson was not absolutely the first to conceive, he was the first to reduce to practicability, and the first to execute, not only upon a working scale, but upon that of the greatest works of engineering of his time—greater than Napoleon's then wonderful highway, that of the Simplon. We refer to the North Midland and Leeds and Manchester Railways, works which yet rank among the greatest monuments of engineering in Great Britain. With these achievements actually before us, the heart throbs with admiration at the genius of the man who, having clearly conceived all the details of so vast a system, could submit with such patience and unshaken conviction to the ignorant and interested opposition to which he was at once exposed."

Middle East Oil

(WESTERN EUROPE AND AMERICA)

By V. S. SWAMINATHAN, M.A., M.Sc.(Lond.)

The continuously expanding demand for power coupled with the inability of coal to meet these greater requirements has increased the economic dependence upon oil, particularly from Middle East sources, until nuclear energy is able to contribute a larger share. The post-war expansion of Middle East oil production is reviewed, together with future plans to satisfy estimated power demand. Problems of transporting a greater tonnage of oil are examined, including possible routes of pipelines and the employment of large tankers. A number of illustrations show some of the plant at the oil-producing centres.

WITH indigenous coal production remaining static, most Western European countries will remain critically dependent on abundant supplies of crude oil and petroleum products until nuclear energy is developed on a substantial scale. Even the United States, with its highly developed oil and natural gas industry, is reckoned to rely, within a decade, on foreign oil supplies to the extent of 150 million tons a year.

The world demand for energy (excluding U.S.S.R. and associates) has gone up by 80 per cent since 1938. In 1955 the quantity of energy effectively consumed by the free world was two and one-third times as much as in 1920. The production of oil and natural gas rose virtually seven-fold during this period—their contribution went up from about one-seventh to over one-half of the effective requirements. The official estimate of the U.K. Government is that by 1975 nuclear power will provide the equivalent of 40,000,000 coal tons. Current consumption of energy in Britain in all forms is of the order of 250 million coal tons a year, and by 1975 it is expected to total 400 million coal tons.

In 1955 oil production outside the Soviet group of countries amounted to 695 million tons a year. The increase in the world's demand for energy cannot be estimated with any assurance of accuracy and an estimate based on an increase of 3 per cent per annum in the world's gross demand for energy results in an oil production in 1975 of 1600 million tons a year. The output of oil by 1965 is expected to go up to 1200 million tons a year.

Middle East "Published Proved" Oil Reserves

(In million tons)

	End 1957	End 1956
Iran	4,295	4,025
Iraq	3,300	2,900
Kuwait	8,100	6,750
Neutral Zone	710	90
Qatar	200	195
Saudi Arabia	5,935	5,275
Southern Arabia	65	—
Other Middle East	60	35
Total Middle East	22,665	19,270
Total Western Hemisphere	8,055	7,585
Total Eastern Hemisphere	27,650	23,665
Total World	35,705	31,250

Proven world oil reserves in 1955 amounted to 25,000 million tons. Total estimates of recoverable reserves made in 1945 were assessed at 70,000 million tons, while in 1954 they were computed at 85,000 million tons. Both these figures excluded the Continental shelves; those including the Continental shelves would exceed 140,000 million tons. It is safe to predict that the ultimate recoverable quantities of oil will prove more than adequate to meet the increased needs of the world economy as it moves into the age of nuclear power.

To-day, two factors stand out: the marked increase in the oil consumption of the United States and the phenomenal growth of the Middle East production. In 1955, the United States was a major net importer of oil, mainly from the Caribbean region and, to a lesser extent, from the Middle East. By 1965 the U.S. oil consumption is reckoned to reach 600 million tons a year, when it will be importing around 150 million tons of oil—an amount virtually equivalent to the Middle East oil production in 1955. Unless there is some significant increase in other parts of the free world, the balance of the U.S. import requirements by then will have to come from the Persian Gulf area. This would bring the total production of the Middle East to 400 million tons a year—an increase of around 250 million tons per annum within a decade.

According to the latest O.E.E.C.'s report on oil, Europe will increasingly depend for its future energy on Middle East petroleum. The expanding European market provides the producing and transit countries with the finance needed for their economic development.

The post-war expansion of Middle East oil production has closely paralleled the rise of the Western European petroleum processing industry. Since the end of the second world war there has been a pronounced trend towards building refineries in consuming areas as against direct imports of refined petroleum products, and this has altered the pattern of international oil trade.

The contribution of oil and natural gas to the energy needs of the O.E.E.C. countries was 6 per cent in 1938, 12 per cent in 1950 and 19 per cent in 1957, and, it is reckoned to go up to 24 per cent by 1960. Demand for petroleum products, including bunkering, more than doubled from 54,000,000 tons in 1950 to 116 million tons in 1956. In 1957, because of the Suez crisis, it was not sub-

Petroleum Production by Main Areas, 1938, 1946 and 1957

(In million tons)

Year	U.S.A.	Caribbean	Middle East	East Indies	U.S.S.R.	Canada	World
1938	168	33	16	8	28	1	274
1946	244	62	35	1	23	1	385
1957	381	153	172	21	98	24	899

Rate of Growth of Production by Main Areas

	U.S.A., per cent	Caribbean, per cent	Middle East, per cent	East Indies, per cent	U.S.S.R., per cent	Canada, per cent	Total, per cent
Average annual rate 1946–1957	+4	+9	+16	+32	+14	+34	+8
1957 over 1956 (Year)	—	+12	+3	+11	+19	+6	+5

International Oil Trade by Main Areas

(In million tons)

Exports	1957	1956	Imports	1957	1956
From:			Into:		
U.S.A.	28	20	U.S.A.	80	71
Other North America	10	9	Other Western Hemisphere	61	56
Caribbean	135	120	Western Europe	137	129
Middle East	153	155	Other Eastern Hemisphere	74	68
East Indies	15	11	U.S.S.R., &c.	1	1
Western Europe	5	4			
U.S.S.R., &c.	7	6			
Total	353	325	Total	353	325

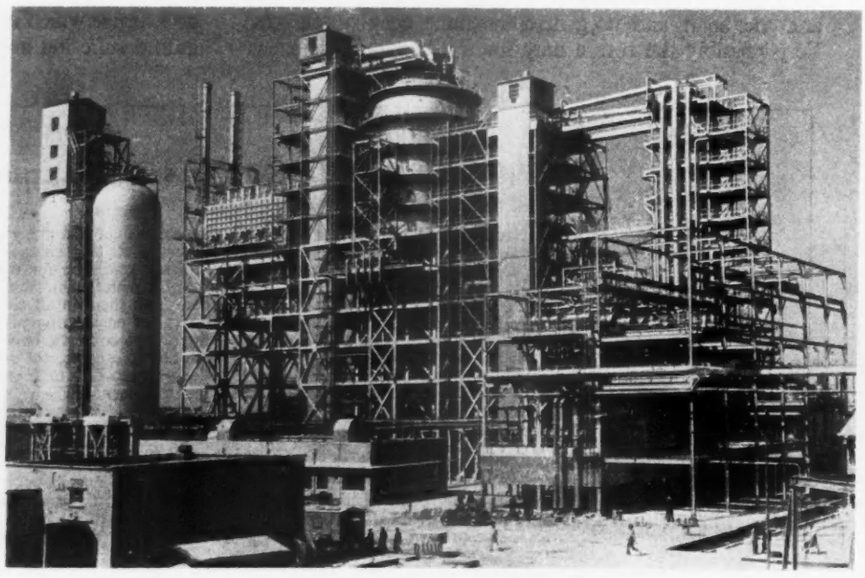


Fig. 1—The catalytic-cracking plant in the Abadan refinery

stantially different from the preceding year's level, but it is from now on expected to expand once more so as to reach around 160 million tons by 1960.

The output of the O.E.E.C. refineries represented nearly 90 per cent of consumption in 1957 and plans are under way to step up processing capacity to match increasing inland needs. Crude oil production of the countries concerned totalled 11,700,000 tons in 1957 or, say, 10 per cent of the refinery throughput in the same year. Hence the greater part of the crude oil processed by the O.E.E.C. plants will continue to be imported from overseas, for the most part from the Middle East. Present estimates are that petroleum production in the O.E.E.C. area will reach 15,000,000 tons by 1960, and at least 20,000,000 tons by 1965. Most of these increases are expected to come from France, Germany, Italy and Holland. Western Europe's proved reserves of crude oil are currently around 186 million tons, equivalent to about sixteen years at present rate of production. A substantial part of it is concentrated in the six main fields given in the order of discovery : Schoonebeck (Holland), Matzen (Austria), Ruehle (Germany), Ragusa (Sicily), Parentis (France), and Gela (Sicily). In 1956 the O.E.E.C. countries had 5600 producing wells, averaging thirty-nine barrels per day. Natural gas production of the region in the same year totalled 6073 million cubic metres, with Italy leading and France taking the second place.

Turning to the pattern of demand for petroleum products, whereas that for petrol in Western Europe rose at a mean annual rate of 9·5 per cent during the 1948–56 period, those of gas/diesel and fuel oil recorded increases of 14 and 17·9 per cent respectively. The post-war European refinery construction programme was executed in two stages. The first extended from 1948 until 1954, during which period the region's refinery throughput was raised from 20,000,000 tons to around 100 million tons per annum. In this phase processing plants were constructed to yield the maximum amount of petrol of good quality ; and a distinctive feature was the building of fluid catalytic cracking units for converting heavy into light fractions. The second stage of building involves the erection of more than 70,000,000 tons a year of additional distillation capacity by the early 1960s, with accent on the maximum output of fuel oils, while quality petrol requirements are met by catalytic reforming of light fractions. Desulphurisation installations are also being built to improve the quality of middle distillates.

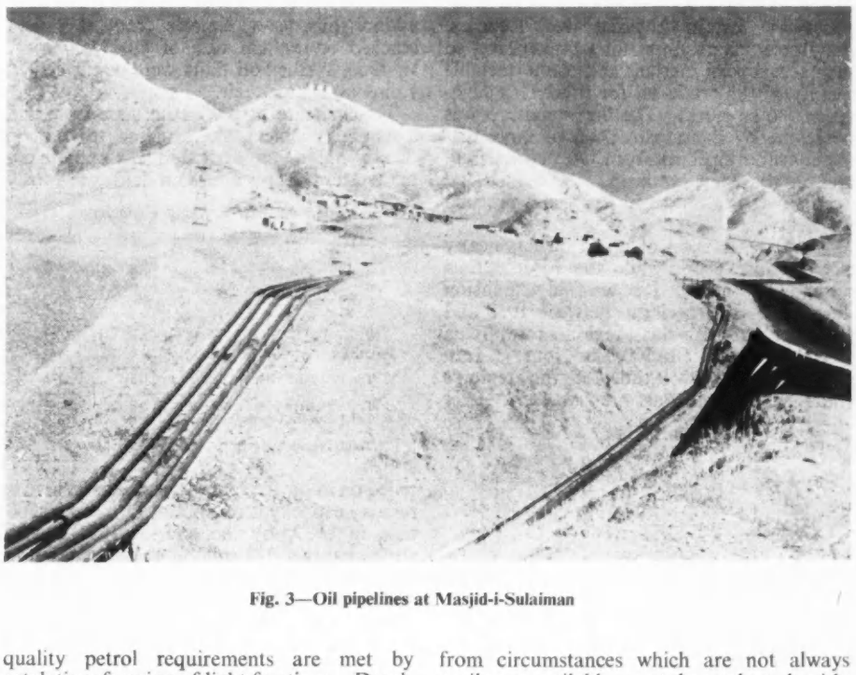


Fig. 3—Oil pipelines at Masjid-i-Sulaiman

In many European countries prices, based on the traditional structure of Western Hemisphere f.o.b. prices plus freight to Europe, can no longer be obtained, whereas the price of crude oil remains unchanged. The question therefore arises as to whether the time has not come for a reappraisal of the methods and relationships which have so far prevailed in the international market. In this reappraisal many problems deriving from circumstances which are not always easily reconcilable must be reckoned with. They relate to the needs of consumer countries which see, as the demand goes up, an ever-growing dependency on oil imports and so wish to participate directly in petroleum production, even outside their national boundaries. On the other hand, countries which are producers and exporters of crude oil don't want to be excluded from the exploitation of their resources, constituting the main source of national wealth.

O.E.E.C. Countries—Oil Consumption Past and Predicted

(In million tons)

	1950		1956		1960		1975	
	Tons	Per cent	Tons	Per cent	Tons	Per cent	Tons	Per cent
Petrol (including white spirits and aviation fuels)	13·3	24	25·0	22	32	21	60	18
Middle distillates (including kerosene)	14·8	27	34·4	30	38	25	260	76
Fuel oil	20·4	38	45·6	40	71	46		
Other products	5·8	11	10·5	8	12	8	20	6
Total	54·3	100	115·5	100	153	100	340	100

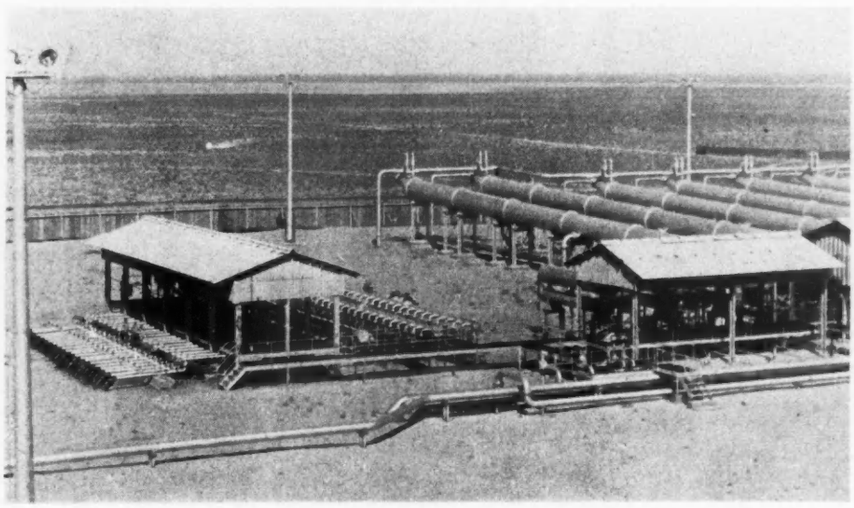


Fig. 2—Part view of a gathering centre in the Buzgan oilfield in Kuwait

Oil in O.E.E.C. Countries, 1957

(In million tons)

Country	Output of crude oil	Consumption (including bunkers) in terms of crude oil*	Output as percentage of consumption
Austria	3·0	2·1	142·9†
France	1·4	20·8	6·7
West Germany	4·0	17·0	23·5
Italy	1·4	14·4	9·7
Netherlands	1·5	8·3	18·1
Turkey	0·3	1·5	20·0
U.K.	0·1	28·6	0·3
All O.E.E.C. countries	11·7	125·0‡	9·4

* 1 ton of petroleum products equals 1·08 tons of crude oil.
† Reparations deliveries of about 1,000,000 tons a year to the U.S.S.R. must be met out of Austrian oil production until 1966.
‡ Estimated.

In most parts of the world the disparity is extreme between national oil assets and domestic liquid fuel needs. This explains why the oil trade has developed under a system which is highly integrated internationally. The operating advantage which the Middle East oilfields enjoy is compounded of high yield per well, large individual fields and freedom for unit development. These assets have, in the past, been

offset by certain physical and technical drawbacks, namely, the long tanker haul to major European markets and the intractable quality of the crude oil for producing high-grade motor spirit. The first handicap was overcome by the construction of large diameter trunk pipelines from the Persian Gulf area to the Mediterranean, and the second overcome by advances in petroleum processing techniques.

World production of crude oil has nearly trebled since 1938, while the Middle East oil industry recorded a ten-fold expansion during the same period. Between 1938 and 1955 output of this region rose from 16,200,000 to 162,500,000 tons. Iran accounted for two-thirds of the region's entire output in the last pre-war year. After

Middle East Oil Production

(In million tons)

	1957	1956
Bahrein	1·6	1·5
Iran	34·9	26·2
Iraq	21·5	30·8
Kuwait	56·4	54·1
Neutral Zone	3·4	1·7
Qatar	6·5	5·8
Saudi Arabia	48·1	47·9
Total Middle East	172·4	168·0
Total Western Hemisphere	579·8	560·7
Total Eastern Hemisphere	319·5	297·0
Total World	899·3	857·7

Iran came Iraq, which reached the full potential of its initial 12in pipelines by 1939.

The second world war interrupted further development for six years, but Middle East production, mainly from Iran, Iraq and Saudi Arabia, was stepped up to 35,500,000 tons in 1946, raising this region's share of world production from 6 to 10 per cent. The existence of vast reserves in the Middle East had been well established before the war, nevertheless, plant, equipment and trained personnel were lacking, while there was insufficient refining capacity to process the mounting crude oil production. Lastly, there was the problem of finding a market for new output ; however, the revival of industry in Western Europe, following Marshall Aid, created a rapidly growing demand for petroleum products of all kinds. Within a decade, the region's oil production had expanded nearly five times the 1946 figure and its share of world output rose from 10 to 20 per cent in 1955, although the total had doubled in the meantime.

Apart from further exploration, by aerial survey and drilling operations which were rapidly increased, many millions of pounds sterling and dollars were invested in roads, on gathering systems, on pipelines and bulk loading installations at Persian Gulf and Mediterranean ports. A 16in pipeline, completed in 1949, was laid from Kirkuk to the Lebanese port of Tripoli, supplementing the 12in pre-war pipeline and providing a total capacity of 7,700,000 tons a year. Another of 30in to 32in diameter was completed in 1952 from Kirkuk to Banias in Syria, with an annual capacity of 17,000,000 tons. Yet a third pipeline, exceeding 1000 miles in length and capable of pumping 15,000,000 tons a year, was built from the Saudi Arabian oilfields to Sidon on the Mediterranean, saving the round trip of approximately 6500 miles by tanker between the Persian Gulf and Suez.

The isolation and the difficult terrain of many Middle East oilfields meant additional expenditure to provide housing and services for personnel. In addition, training centres were set up to give instruction to promising nationals. Prospecting in the meantime led to more important discoveries. In south Iraq oil was struck at Zubair, near Basrah, in 1948. This field was connected to Fao terminal on the Persian Gulf in 1951, and within four years exports from this field reached an annual rate of 8,000,000 tons. In 1953, further oil finds were confirmed at Rumaila, near Zubair.

This increase in petroleum supplies posed a refining problem, and a major programme of new refinery construction was undertaken in Western Europe, which had previously

Middle East Refining Capacity

(Million tons per annum)

	End 1957	End 1956
Aden	5·0	5·0
Bahrein	10·0	10·0
Egypt	4·0	3·3
Iran	15·1	15·1
Israel	4·0	4·0
Saudi Arabia	10·8	10·8
Others	4·4	4·4
Total Middle East	53·3	52·6
Total Western Hemisphere	611·9	591·7
Total Eastern Hemisphere	340·0	313·0
Total World	951·9	904·7

relied on imported refined products. Whereas refinery capacity here amounted to 16,800,000 tons in 1939, by the end of 1954 it was stepped up to 110 million tons per annum, and this upward trend still continues. Another large programme of capital construction resulted from the planned expansion of petroleum production. Oil must be transported from the Middle East by sea ; hence the boom in world tanker construction.

This development of production and refining capacity illustrates the speed with which the Middle East oil industry rose to its new opportunities in Western Europe. Equal initiative and resource have been displayed in the way it streamlined its marketing facilities to deal with changes in demand, as between types of oil product. Consumption of petroleum products in Western Europe rose from 27,000,000 tons in 1938 to over 75,000,000 tons in 1954, of which over 80 per cent came from Middle East sources. A simple breakdown of these figures reveals several interesting changes in the demand for specific types of oil product. A major development relates to the growing use of fuel oil for industrial processes, whilst increasing quantities are also employed for generating electricity and gas. Mechanisation of farming has also called for more diesel and gas oil. The pattern of demand is changing towards a greater preference for the heavier diesel oils for commercial transport vehicles, accentuated by more economical consumption of petrol by modern passenger vehicles. Trends in railway locomotion will result in a large-scale switch from coal-driven to diesel-driven locomotives, where electrification is either uneconomic or impractical. The demand for lubricants is a barometer of industrial expansion, whilst the growing use of oil for domestic space heating portends a steady rise in living standards. These developments have brought others in their train. Much of the oil-producing equipment for the Middle East and plant for refinery construction is now being fabricated in Britain and Western Europe, thus giving birth to a new industry. Tanker construction has meant prosperity for British and European shipyards, and the civil construction industries now have a large stake in important new fields of activity.

The United States oil companies are now playing an important part in producing, refining and marketing oil in the Middle East as well as in Western Europe. In mid-1956 the Middle East accounted for a third of the world's oil output, and possessed two-thirds of its proven reserves. The ownership of these resources has shifted and widened with their growth. Until the 1920s America was a substantial net exporter of oil and products and, hence, the U.S. companies were not keen on developing petroleum resources abroad. But, when the growth of overseas supplies was giving their competitors a freight advantage—whilst, about the same time, the exhaustion of domestic reserves loomed large—they found themselves shut off from exploration and exploitation in British, French and other colonial territories. Their choice was to branch out first into South America and then into the Middle East.

In the latter region the San Remo agreement reserving oil for British and French interests aroused strong American opposition, the more so as the U.S. oil corporations were meeting 60 per cent of all foreign petroleum needs. The American companies were thus in a strong bargaining position. In 1922 Sir Charles Greenway, chairman of the Anglo-Iranian Oil Company, opened negotiations with the seven interested American companies, and in 1928 matters were settled by the " Redline " agreement. Under it, the Turkish Petroleum Company was equally divided between Shell, Anglo-Iranian, the

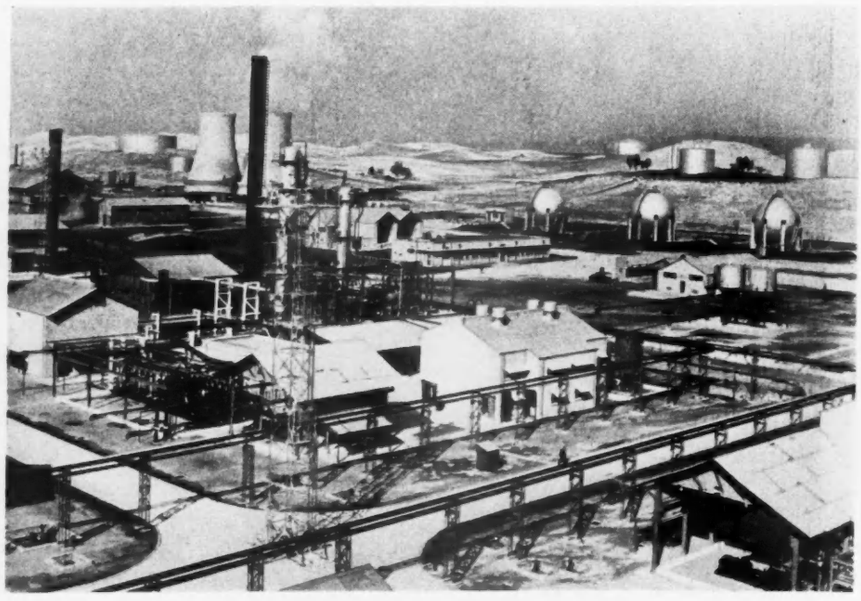


Fig. 4—Crude oil process plant at Kirkuk in Iraq

French and Americans—with all four agreeing to buy Gulbenkian's 5 per cent share of production. The U.S. share was represented by the Near East Development Company, the shareholding of which was eventually agreed thus : 41⅔ per cent Jersey Standard, 41⅔ per cent Socony-Vacuum (now Socony Mobil), and 16⅔ per cent for Gulf Oil.

A British company (Eastern and General Syndicate), formed by Major Frank Holmes, obtained oil concessions in Saudi Arabia, the Neutral Zone and Bahrein. It failed to sell the first two, since the Anglo-Iranian Oil Company took a poor view of their petroleum prospects ; but in 1927 it managed to interest a subsidiary of Gulf Oil in the Bahrein concession, and in a half-negotiated concession in Kuwait. Gulf Oil, at that time, was negotiating for an interest in Iraq Petroleum Company. When the " Redline " agreement was signed later, it submitted the Bahrein proposition which was turned down. Later, it sold the Bahrein rights to California Standard (" Socal "), retained the Kuwait option and contracted out of the I.P.C. Despite British Government protests, California Standard commenced drilling in Bahrein forthwith and found oil in commercial quantities.

This Bahrein discovery completely transformed the Arabian petroleum picture. It opened up a possibility of further major oil finds in Kuwait and Saudi Arabia outside the control of Iraq Petroleum Company. Then the Anglo-Iranian Oil Company launched a counter-attack and tried, without avail, to procure a concession over the rest of Bahrein. It obtained one at Qatar and handed it over to Iraq Petroleum Company. It failed to persuade the latter company to bid for an Arabian concession, which ultimately went to " Socal " in 1933. Anglo-Iranian's only important success, with the U.K. Government support, was to invoke the treaty clause at Kuwait, and so force a fifty-fifty share agreement on Gulf Oil.

In the meantime " Socal " rapidly consolidated its position in Bahrein. But it could only find an outlet in world markets for this production by price-cutting, which was bound to affect adversely its interests elsewhere. The problem was solved in 1936, when it transferred a half interest in Bahrein and Saudi Arabia to the Texas Company in exchange for Far Eastern marketing facilities. Two years later a major oil strike was made in Saudi Arabia, and the two American companies concerned secured a new concession on it, notwithstanding severe international competition. Production and refining rose rapidly during the second world war, and the problem of marketing the new oil was solved by selling substantial quantities to the U.S. Government.

Percentage of Petroleum Sources of Major International Oil Companies, 1957

	Kuwait	Saudi Arabia	Persia	Iraq	Total Middle East	Other Eastern Hemisphere	U.S.	Venezuela	Canada	Other Western Hemisphere	Total output (million metric tons)
Standard Oil (New Jersey)	—	12·5	2	2	17·5	3	21	48·5	4·5	5·5	119
Royal Dutch-Shell	16*	—	4	4·5	26·5	11	17	42	0·5	3	113
Gulf Oil	48·5†	—	3	—	51·5	2	31	14	1·5	—	58
Texas Company	—	28·5	4·5	—	33·5	7	42	—	4	13·5	53
British Petroleum	57·5	—	28·5	10	98	0·5	—	—	0·5	1	50
Standard Oil of California	—	33·5	—	—	40·5	8·5	37·5	10·5	3	—	45
Socony Mobil Oil	—	14·5	7·5	7·5	31·5	7	39	16·5	4	2	36
Compagnie Francaise des Petroles	—	—	23	57·5	98·5	1·5	—	—	—	—	9
Phillips Petroleum	—	—	—	1·5	20·5	—	72·5	5·5	1·5	—	9
Getty - Tidewater Group	—	—	—	3·5	26·5	—	68·5	—	5	—	8
Total output (million metric tons)	57·3	49·0	35·5	21·0	176·8	34·5	352·0	146·3	24·5	34·3	768·4

* Under long-term special supply contract with Gulf Kuwait.
† Including contract under *.
Note.—The " Total Middle East " column also includes the output of Qatar, Bahrein and the Kuwait/Saudi Arabia Neutral Zone. The " Other Eastern Hemisphere " totals are mainly attributable to production in Indonesia and Borneo ; while the " Other Western Hemisphere " column refers principally to Latin America outside Venezuela.

After the war the American companies operating in the Middle East decided to drop the " Redline " agreement altogether, since it hampered them from taking an interest in the mounting Saudi Arabian oil output, where the two producing partners needed both capital and adjacent European markets. The Standard Oil of New Jersey and Socony-Mobil forthwith bought 30 and 10 per cent shares in the Arabian American Oil Company (" Aramco ").

Middle East Oil Companies

Companies	Controlling Groups
Kuwait Oil	50% British Petroleum (B.P.) 50% Gulf Oil
Aramco	30% Standard Oil of New Jersey 30% Standard Oil of California 30% Texas Oil 10% Socony Mobil
Iraq Petroleum Mosul Oil Basrah Oil Qatar Oil	23·75% B.P. 23·75% Royal Dutch Shell 23·75% Cie. Francaise des Petroles 23·75% Near East Development Corporation 5% Participations and Explorations
Iranian Oil Exploration and Producing Company (" Consortium ")	40% B.P. 14% Royal Dutch-Shell 6% Cie. Francaise des Petroles 7% Standard Oil of New Jersey 7% Standard Oil of California 7% Texas Oil 7% Socony Mobil 7% Gulf Oil 5% Iricon Agency (U.S. Companies)

Other Middle East oil developments are briefly stated. Aminoil and Pacific Western took over production in the Neutral Zone. The final shift of influence arose from the Iranian dispute. Its settlement passed control of Iranian oil to an international consortium of petroleum companies, in which American corporations obtained a 40 per cent interest.

Under the prevailing pattern of Middle East oil concessions virtually all the production is in the hands of eight major international petroleum companies, representing British, Dutch, American and French interests. Since the end of the last war, however, a steadily increasing number of American and other independent concerns have acquired oil interests in the less productive areas of the region.

The fifteen countries of the Middle East where oil activity is in progress are for convenience divided into three groups of five each, thus : (1) large producers responsible for 97 per cent of the total output in 1956, namely, Kuwait, Saudi Arabia, Iraq, Iran and Qatar ; (2) five minor oil-producing territories, viz. Egypt, Saudi Arabia/Kuwait Neutral Zone, Bahrein, Turkey and Israel, together responsible for the remaining 3 per cent of the region's combined production ; (3) five countries not producing oil, Jordan, Syria, Lebanon, Yemen and Dhofar (east of Aden), where concessions have been granted mostly to independent concerns (largely American), but no paying quantities of oil have so far been found. In addition, A.G.I.P., a subsidiary of E.N.I., the Italian State Petroleum Company, has been granted, pending ratification by the Iranian Parliament, an oil concession at Qum in northern Iran, as well as three other smaller areas—east of the Consortium's area and west of Pakistan's border and two offshore in the Persian Gulf. The eventual operation of the prolific Qum field may well have an important bearing on the future trend of Iranian politics and economics.

Most of the major Middle East oilfields are situated adjoining the head of the Persian Gulf with ocean terminal near to hand. The bulk of Iraq output, however, is far inland—the Kirkuk fields are equally afar from the Persian Gulf and the Mediterranean. About 25,000,000 tons of Iraq oil (out of a total production of approximately 33,500,000 tons) pass annually through the 550-mile pipelines from Kirkuk to Banias in Syria, and the 530-mile pipelines from Kirkuk, through Syria, to Tripoli in Lebanon. Three lines, 12in, 16in and 30in in diameter, carried the oil together as far as Homs in Syria, where the 30in line branched off to Banias and the other two continued on to Tripoli.

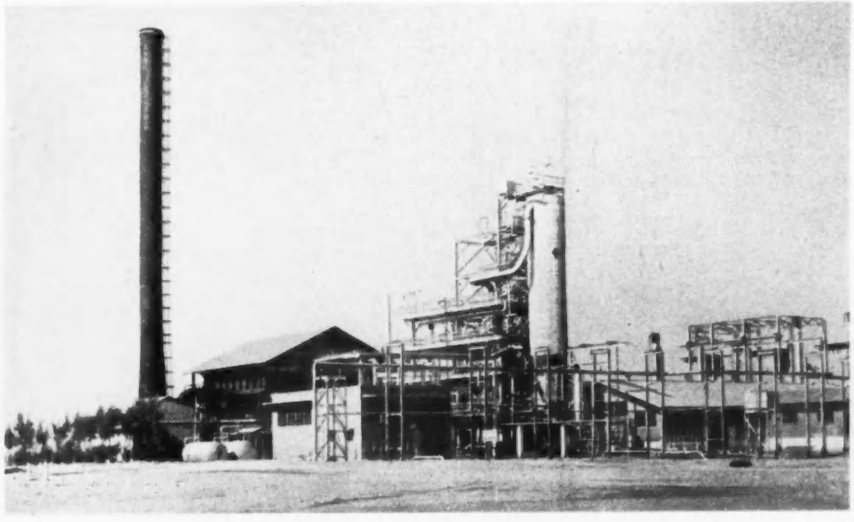


Fig. 5—Refinery at Mina-al-Ahmadi

The Banias line has an annual throughput of 17,000,000 tons, and the Tripoli lines a combined throughput of 7,700,000 tons. Each has seven intermediary pumping stations along their route. There is another pipeline from Kirkuk to Haifa, but this has been disconnected at the Israel-Jordan border for over nine years.

About 8,500,000 tons of Iraq's annual production comes from the Basrah Oil Company's fields at Rumeila and Zubair, south-west of Basrah. A 12in feed line carries Rumeila's output for 18 miles to Zubair, where it is fed into the 24in and 13in pipelines, which take the company's crude oil 65 miles to the ocean terminal at Fao. The throughput capacity is 10,500,000 tons a year, and there is one pumping station at Zubair.

Aramco's production from Saudi Arabia is shipped either from the Persian Gulf port at Ras Tanura, or from Bahrein via the submarine pipeline from Dammam, or via the Tapline and the Eastern Mediterranean. Tapline is the longest pipeline in the Middle East, running from Abqaiq adjoining the Persian Gulf coast, for 1062 miles, through Jordan and the Lebanon to Sidon on the Mediterranean coast. It is a single pipe, 30in in diameter, with a throughput capacity of around 16,000,000 tons a year.

Bahrein Island has its own terminal and refinery and a 34-mile submarine pipeline links the island with the Aramco lines on the mainland of Saudi Arabia.

The main Iranian oilfields are in the Zagros mountains, 200 miles north of the headwaters of the Persian Gulf, and are linked to the sea terminals at Abadan by a network of pipelines with an aggregate length of 2000 miles.

In 1946, the first commercial year of production, Kuwait accounted for 800,000 tons of crude oil. A decade later the output totalled 54,000,000 tons. The number of wells connected during this period rose from eight to 211. One key to this unprecedented expansion and to the future is the deep-water oil pier at Mina al Ahmadi, where 2603 tankers loaded last year.

The capacity of Mina al Ahmadi is being expanded. Current facilities comprise an oil pier with eight loading berths and five sea berths, the latter consisting of two submarine lines to each berth, and the expansion programme includes four additional submarine pipelines to form two submarine berths. One of these is a 24in diameter line, 7300ft long, to export fuel oil coming from the new distillation units forming part of the Kuwait refinery expansion project. The other line, 12in diameter, is to be used for shipping marine diesel oil. The second new berth will consist of a 24in diameter crude line with a loading capacity of 2000 tons per hour, and a 12in diameter fuel oil line. On land a ninth gravity line of 32in diameter was commissioned in 1957. These projects increase the crude oil loading capacity of the port from 50,000,000 to 75,000,000 tons a year.

An agreement made by the Iranian Government and an Italian company meant that the former granted producing rights to an operating concern owned jointly by the National Iranian Oil Corporation (N.I.O.C.), a State entity, and the A.G.I.P. Mineraria, an Italian State undertaking. Under it the Iranian Government will share profits of the venture, if successful, with the operating company, on a fifty-fifty basis. Since, however, the former owns half of the operating concern, it will also get half of the remaining profits. This brings Iran's share up to 75 per cent with the other 25 per cent going to A.G.I.P. Hence, this pact was designated as 75–25. There are, however, other factors in this arrangement which are apt to be overlooked. Thus, the land to be explored is most attractive to oil prospectors because of its proximity to producing fields, and there is little question that oil companies would have competed for the right to explore it by offering substantial bonus payments as in Venezuela and Canada. In this agreement Iran has consented to forego such payments. Furthermore, the Iranian Government is committed to contribute half the capital required in the development of the oilfields if oil is found. Under the conventional fifty-fifty agreement Iran would be required to make no financial investment whatsoever.

Another pact, negotiated between a private Japanese company and Saudi Arabia, is referred to as fifty-six-forty-four. Under it, the latter country is to receive 56 per cent of the net income of all phases of an integrated operation (including transport, refining and marketing) outside, as well as inside, the country. But, in fact, the terms may not be as favourable to Saudi Arabia as the catch phrase fifty-six-forty-four, and the sharing of income from the integrated operation would imply. For one thing, the Saudi Arabian Government had agreed to forego bonuses for granting exploration rights, which in the light of the area involved, could have been considerable. For another, the requisite facilities for transporting, processing and marketing do not yet exist. Even if oil is found, it may be years before there is a net profit for the integrated operation to be shared.

In fine, all agreements between countries with potential petroleum resources and oil companies must necessarily be worked out in terms of the specific situation : the relative geological prospects, the risks and costs involved, the geographical situation, the availability of market outlets and many other factors.

Fifty-fifty is not so much a magic formula as a workable proposition. As an approach to the problems of agreement it has advantages that the experience of many nations, and several oil companies, has proved. It relieves the oil-producing country of any financial risk, placing it on the company concerned, which is in a position to evaluate it, and spread the risks of the search for oil over many areas. Any basis other than fifty-fifty could well give rise to an imbalance of interests likely to reduce the attractiveness of the venture for one or other of the parties. This applies particularly to countries whose citizens do not have to risk capital, technical resources and organisations to locate, produce, refine and market diverse petroleum products. This is broadly true of most of the Middle East countries at the present time.

Middle East—Growth of Oil Royalties

(In £ million)

	1950	1952	1954	1955	1956	1957
Kuwait	4	60	78	100	100	N.a.
Saudi Arabia ...	40	60	65	100	100	N.a.
Iraq	5	40	68	74	69	49
Iran	16	—	—	30	54	76
Qatar	—	2	7	*13	N.a.	N.a.
Bahrein	1	1	4	3	N.a.	N.a.

While the importance of the Middle East as a source of oil to Britain and Europe is very well known, its role as a market for British goods is not as well realised. Britain is the largest single supplier of goods to this area, accounting for around one-third of its foreign supplies. The U.K. exports to the Middle East in 1957 were worth £154 million, or 5 per cent of its total exports. The three most important and rapidly growing outlets for the British manufacturers are the petroleum producing territories—Iran, Iraq and Kuwait. Its major shipments to them consist of machinery and vehicles of various kinds.

In 1957 Iran's imports from Britain (machinery, electrical apparatus and iron and steel products, partly for use in refinery construction and in part for the Khuzistan development scheme) were worth £36,000,000. Her exports to the U.K. were of the value of £36,000,000, mainly petroleum and to a minor extent textile yarns, raw wool and hides. Britain's shipments to Iraq last year were valued at £34,000,000, spread chiefly between machinery, manufactured goods and electrical appliances. In the same period close to 90 per cent of Iraq's exports was petroleum valued at £110 million, of which £11,000,000 worth was sent to Britain. Kuwait's oil exports to the United Kingdom in 1957 were valued at £134 million, or virtually half of its oil shipments, and Britain's

Fig. 6—Oil harbour at the Aden refinery

shipments to this tiny sheikhdom were worth £25,000,000, or half of its total imports. The other Persian Gulf states—Bahrein, Qatar, Muscat and Oman and the Trucial sheikhdoms—took £15,000,000 worth of imports from Britain, and their combined exports to the U.K. (mainly oil) were valued at around £20,000,000.

The Iraq Development Board is at present engaged on a six-year plan, ending 1960, during which period £500 million will have been spent largely on long-term projects in flood control and irrigation, roads and public buildings. The U.S. corporations, in 1957, carried out around £250 million worth of work, roughly two and a half times that of British firms. To complete the subject, last year (1957) the U.K. imports from the Middle East, consisting mainly of crude oil and refined petroleum products, totalled £211 million, while its exports to this area amounted to £154 million.

For the movement of oil and products over long distances marine transport is generally cheaper for the same mileage than pipeline. Thus, the Tapline athwart Arabia from the Saudi Arabian oilfields to Sidon, a distance of approximately 1000 miles, reduces the westward tanker haul by some 3700 miles. Moreover, tankers using the Suez Canal have to pay transit dues equivalent to the cost of a further 1000 miles of sea voyage. Therefore, the cost advantage for the pipeline under these conditions is considerable.

But this cost situation is in a state of flux, because the size of the ocean-going tanker has gone up markedly since the second world war. The outlay for moving oil in tankers of 12,000 tons deadweight was stated in 1953 to be roughly one-quarter higher than in vessels of 32,000 tons. Larger tankers will still further reduce costs.

Estimates published by the Institute of Petroleum in 1954 indicated that if a large diameter pipeline (30in and over) was used to its full capacity, its costs per ton-mile would be double those of a 32,000-ton tanker. Smaller diameter pipelines, or those employed at less than full capacity, would have appreciably higher costs. Reasons for this are set out partly in terms of steel and power needs—the steel requirements for moving the same quantity of oil the same distance being more than twice as high, and power needs virtually double, in a 30in pipeline as in a 32,000-ton tanker. The full comparison would, however, be highly complex, and cannot be computed precisely with data to hand. Tankers, for instance, would almost certainly suffer more corrosion than pipelines, and call for more maintenance.

Of the total Middle East oil output of 145 million tons (20·6 per cent of the world production), 67,000,000 tons passed through the Suez Canal, compared with 40,000,000 tons via the pipelines reaching the Mediterranean. In mid-1956 the passage of tankers was beginning to approach the canal's total capacity. Allowing for the completion of the programme of improvement under way during the first half of 1956, the transit capacity would have increased to between 160 million and 180 million tons. Then, assuming that plans to enlarge pipeline capacity are also proceeded with, the Suez Canal should be able to cope with demands made on it by 1965. But, a decade later, it is reckoned that there may be 300 million to 350 million tons of crude oil seeking south-north passage through the canal, an amount vastly in excess of its prospective capacity.

Transit dues paid by tankers using the canal are approximately the equivalent of a further 1000-mile journey. From the Persian Gulf to the U.S. east coast the distance round the Cape is about 12,000 miles, or nearly 3600 miles longer than through the Suez route, but it is cheaper per ton of oil moved to send a super-tanker (40,000 tons deadweight or over) to the Atlantic coast of America via the Cape than a standard-sized ship (say, 32,000 tons deadweight) through the Suez Canal. The main drawback of the Cape route pertains to the extra time taken.

The future costs of moving oil from Persian Gulf ports to locations west of Suez will be conditioned by the costs of operating a fleet of large, efficient and economical tankers, in competition with overland pipelines. Such a condition is healthy for all concerned—producers, transporters and consumers—since it assures that the most economical form of transport will be forthcoming to deal with the increased quantities of crude oil to be moved to market. At present, a pipeline has only a slight cost advantage over tankers transporting oil from the Persian Gulf to the Mediterranean. Following their relatively low operating costs giant tankers of to-morrow will undoubtedly wipe out this advantage. In the immediate future, therefore, the pipelines already in operation between these points will be hard pressed to keep expenses low enough to meet this challenge. New pipelines will be economically justified only under the most favourable conditions, namely, low construction costs, efficient management, continuously high throughput and the co-operation of the Governments of the countries through which they pass.

A tanker has the important advantage of flexibility. Thus, if one route is found unprofitable, it can be transferred to another. A pipeline is a fixed facility ; therefore, the requisite operating costs and security of operations can be attained only if the following basic conditions are met (so that the construction costs are justified in relation to tanker haul).

The line must be operated at full capacity ; the line must be efficient, and have low operating costs, which means large diameter lines (30in to 36in or more), with a minimum number of pumping stations equipped with simple and robust machinery ; they must be built at a minimum cost by skilled planning and construction technique ; the Middle East Governments concerned must provide a stable, favourable economic climate, to justify the huge investments called for by new pipeline facilities and provide continuously for the period of the concession ; a security for title to property or rights and sanctity of contracts entered into, non-interference with managerial control of the company's normal operations, and the opportunity to make a fair profit on the capital investment.

The Suez Canal Company has been faced with the problem of enlargement and improvement, to enable the canal to meet the continual growth of shipping needs, and, by way of comparison, close on 100 million cubic yards of dredging and excavation were required for the digging of the original canal opened in 1869, since when 500 million cubic yards have been dealt with.

In 1954, plans for the Eighth Development programme were formulated, the goal being the transit of 18,000 ships a year (13,200 in 1954), including tankers of 36ft draught, each carrying approximately 40,000 tons of oil. Its execution would have made possible an annual traffic through the canal of over 100 million tons of petroleum (45,000,000 tons in 1954).

The major oil companies estimated that the probable amount of oil traffic by 1970, taking into account the increased petroleum needs of Western Europe, would total some 250 million tons. Allowing for the trend towards larger tankers, and also for other traffic, the number of ships to be taken by the canal at that period was placed at 30,000 a year, and it appeared necessary to enlarge the navigable channel to take tankers drawing up to 40ft with a deadweight of the order of 60,000 tons.

World Tanker Fleet at end of 1957

(2000 deadweight tons and over.) By Flag and Ownership

Flag	Oil company	Others	Total	Share of total, per cent
	(Million tons deadweight)			
British	5·8	2·6	8·4	17
Liberian	1·4	6·9	8·3	17
U.S.A.	4·3	3·6	7·9	16
Norwegian	0·1	7·2	7·3	15
Panamanian	1·7	1·7	3·4	7
Other Western Europe	3·4	6·8	10·2	20
Other Western Hemisphere	1·2	0·5	1·7	3
Other Eastern Hemisphere	—	1·5	1·5	3
U.S.S.R., &c.	—	0·9	0·9	2
Total	17·9	31·7	49·6	100
Fleet at end of 1956	16·7	27·7	44·4	
Net increase, 1957	1·2	4·0	5·2	

The Suez Canal is being operated successfully by the Egyptian Government. The daily average of ships in transit was 47·9 last February (1958), compared with 41·9 two years previously. Income was running at a correspondingly higher rate of around £40,000,000 a year, against £35,000,000 per annum under the Suez Canal Company's management. Last May, it was opened again to vessels of 35ft draught as in 1956.

Three American companies signed contracts last July (1958) to carry out a two-year programme to deepen and widen the Suez Canal. They are the Atlantic Gulf Pacific Company, the Standard Dredging Corporation and the Hawaiian Dredging and Construction Company. It provides for deepening the canal in certain parts to permit passage of ships of 37ft draught. At present ships of more than 34ft draught cannot get through. The canal will also be widened at certain parts. The total cost of the operation is around £6,540,000.

Details of the so-called Nasser plan are under discussion. In outline, it would cope with an estimated annual oil traffic of 275 million tons by 1970, by doubling the canal throughout its length, and providing a north-bound channel capable of accommodating fully-laden tankers of up to 70,000 tons drawing up to 45ft of water. Such a project, which would call for new and bigger tugs and dredgers, enlarged port facilities and more pilots, would cost well over £100 million and take fifteen years to complete. To finance such a development President Nasser promised last April to reserve 25 per cent of canal earnings—say, £10,000,000 a year at present rates. It will, however, be necessary for the Egyptian Government to raise a loan before it can embark on this expensive undertaking.

International oil companies have been reviewing their future plans for moving markedly increased tonnages of Middle East oil in about ten years' time to Europe and the United States. If plans for enlarging and deepening the Suez Canal are carried out on time this route might be capable of handling, say, 130 million tons of oil by 1965. Turning to the alternative method of transport, the pipeline capacity from Iraq and Saudi Arabia to the Mediterranean is 40,000,000 tons. The capacity of the Tapline is being raised to 20,000,000 tons, and this could further be stepped up to 25,000,000 tons. Iraq Petroleum Company has plans to add 9,000,000 tons to its pipeline to Tripoli by partly looping the line, and has also con-

World Tanker Building by Age, Size and Propulsion

(Million tons deadweight)

Year of construction	Size in thousand deadweight tons					Total
	Under 15	15–30	30–45	45–65	Over 65	
Before 1933	2·3	0·2	—	—	—	2·5
1933–1939	1·4	0·4	—	—	—	1·8
1939–1946	3·4	10·8	—	—	—	14·2
After 1946	3·5	19·6	7·1	0·6	0·3	31·1
Total	10·6	31·0	7·1	0·6	0·3	49·6
Steam	2·7	18·1	6·2	0·6	0·3	27·9
Motor	7·9	12·9	0·9	—	—	21·7

sidered the feasibility of gaining another 7,500,000 tons by diverting its Haifa pipeline to Sidon. If all these projects materialise, the throughput of the Mediterranean pipeline terminals would total, say, 66,000,000 tons.

The building of a pipeline from the Gulf of Aqaba to some Israeli port holds promising prospects. Apart from the formidable political risk, the main disadvantage of such a line would be the considerable loss of time entailed in loading and unloading at the terminals.

New Tanker Building Under Construction or on Order

(Million tons deadweight)

	Size in thousand deadweight tons					Total
	Under 15	15–30	30–45	45–65	Over 65	
As at end of 1957	0·2	8·0	13·3	9·5	1·9	32·9

Another pipeline from the Persian Gulf to the Mediterranean would go some way towards meeting the oil needs of Western Europe and America in 1965. This would link the oilfields of Kuwait, South Iraq and possibly Iran with the Turkish port of Iskenderum. The most direct route traversing Syria would be around 900 miles ; whilst a route athwart Iraq and South Turkey, avoiding Syria, would be just over 1200 miles, some of it through difficult terrain. The outlay on a 30in diameter pipeline, with a capacity of 25,000,000 tons a year might vary from £70,000,000 to £100 million, depending on the topography, and for a 40in diameter pipeline, with a capacity of 45,000,000 tons, from £95,000,000 to £125 million. This pipeline would save a 7000-mile haul round Arabia and back by tanker, apart from relieving pressure on the Suez route.

There is, moreover, a trans-African pipeline proposition, 2000 miles long, 24in in diameter, over an all-Commonwealth route from Mtwara to Walvis Bay, with a pumping capacity of 30,000,000 tons and costing around £200 million. Its capacity would be sufficient to fill one super-tanker of 85,000 tons deadweight every day at the Walvis Bay terminal, nearly 5450 miles from Southampton and 6250 miles from New York. From Abadan in Persia to Mtwara the distance is 3450 miles and smaller tankers could carry crude oil on this shorter run. This all-Commonwealth pipeline is less exposed to wartime destruction, or peacetime extortion, than any other route so far developed or planned, and points in its favour are the prospect of increasing tolls that may be exacted by Egypt and the growing risk of continued dependence on the Mediterranean route.

During the second half of this century world energy requirements are reckoned to rise at approximately 2 per cent per annum compared to a level of about four times that of to-day (*vide* " Peaceful Uses of Atomic Energy," *Proceedings of the International Conference in Geneva*, August, 1955, Volume 1, page 38 *seq.*).

Estimated World Consumption of Energy

Year	Assumed annual compound rate of growth		
	2%	2½%	3%
	(Thousand million tons of coal equivalent)		
1950	3	3	3
1975	4·5	5	6
2000	7·5	9·5	12

Below is an estimate of the world reserves of fossil fuels, in thousand million tons of coal equivalent :

Coal and lignite	3000
Oil and gas	300
Oil shale and tar sands	150

It seems unlikely that coal production can expand at anything like the most conservative estimate, and, in fact, a figure of 0·5 per cent has been suggested. Although foreseen oil and natural gas resources will be more than ample to fill the energy gap by the end of the century, it is more than likely that the utilisation of these for power production may well be overshadowed by increased demand for petrochemicals, and new materials for plastics, &c., as well as the more specialised liquid fuels which petroleum alone can furnish.

It appears reasonable to expect nuclear power to bear the brunt of the expansion in energy demand and to be the provider of a large proportion of the world energy needs by A.D. 2000. The civil nuclear programmes, so far announced, point to this goal :

	Megawatts installed capacity	No. of stations	Percentage of total electricity generation capacity	Percentage of total electricity consumed
United Kingdom	5,000–6,000 by 1965	19	15	25
United States of America	1,580 by 1964	27	1·6	2·7
France	850 by 1965	7	*c.* 3·0	5·6
Russia	2,000–3,000 by 1960	5	*c.* 8·0	*c.* 12
Russia	(4,500–6,000 by 1965)	(10–12)	(*c.* 9–12)	(*c.* 14–18)
Sweden	400 by 1966	4	2–2·25	3
Czechoslovakia	1,650 by 1970	6–8	25	33
Euratom	15,000 by 1967	35–50	*c.* 20–25	*c.* 30

Other countries actively engaged in planning nuclear power programmes include Western Germany, Norway, Italy, Poland, Israel, Australia, India, South Africa and Brazil.

Even at the dawn of the next century nuclear power can be considered as more likely to affect the balance of the products derived from crude oil than to supplant it.

To-day, the United States is well fitted to point out that the way to national development for Middle East countries must come along the road of respect for others as well as insistence on their rights. They should be made to understand that neither government agreements nor private contracts are to be entered into lightly, or quickly abandoned when such a step seems expedient. Signed contracts have a validity of their own and when a Sovereign state is a party to a contract it may not repudiate its pledged word with impunity. By and large, the experience of oil companies in the Middle East has shown that a willingness to play fair and to meet reasonable points of view half-way brings a corresponding response from those in authority and the inhabitants of the countries.

Mechanics of Train Running

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E., M.I.Loco.E.

The degree to which economic and engineering factors are bound up in the enterprise of running a railway, though appreciated in the broadest sense, has not always been fully implemented in the past. Much has been done in recent years to clear away some of the misconceptions, uncertainties and prejudices of old traditions, and in a recent paper presented to the Institution of Locomotive Engineers, Mr. S. O. Ell has collated a vast amount of data based on his work at Swindon. In this article the author, who has had the privilege of seeing something of this work at first hand, reviews and comments upon the paper.

IT was as long ago as 1885 that the distinguished American engineer, A. M. Wellington, said : " It would be well if engineering were less generally thought of, and even defined, as the art of constructing. In a certain important sense it is rather the art of not constructing; or to define it rudely but not inaptly, it is the art of doing that well with one dollar which any bungler can do with two after a fashion." That saying, of more than seventy years ago, might well be the battle-cry of all who are concerned with the job of trying to increase productivity to-day, and that would include everyone in the service of railways. Mr. Ell's paper strives to show how a precise knowledge of the mechanics of a train in motion can be used as a well-nigh priceless tool in the operational management of a railway. The theory is well known. It has been expounded, and commented upon, at length in the past by Lomonosoff, W. E. Dalby, and others ; but the applications were in the majority of cases crude, if not downrightly inaccurate due to the rough and ready methods by which the experimental data were obtained. In his work as assistant, research and development (rolling stock) to the Chief Mechanical and Electrical Engineer of the Western Region, British Railways, Mr. Ell has been responsible for carrying out much very important experimental work with the former Great Western dynamometer car, and on the stationary testing plant in Swindon works, and it can now be said that perhaps the most hitherto elusive of all experimental quantities, train resistance, has been established to a high degree of accuracy, and from this fundamental quantity, Mr. Ell's work in the planning of train schedules has followed naturally.

At the outset, in displaying the time-table for a section of important main line in graphical form (Fig. 1) Mr. Ell produced a virtual epitome of the whole problem of

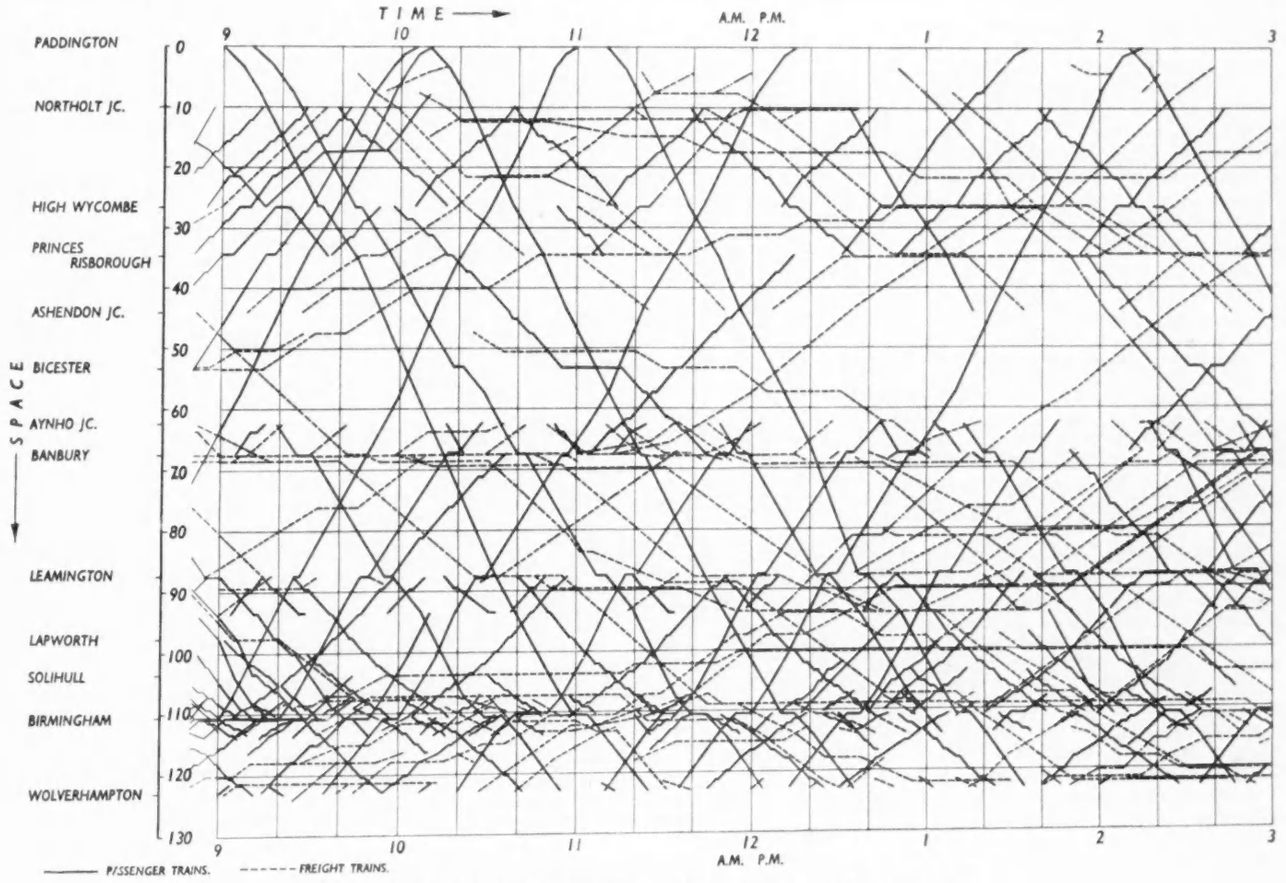


Fig. 1—Graphical time-table diagram. Western Region, Paddington–Wolverhampton

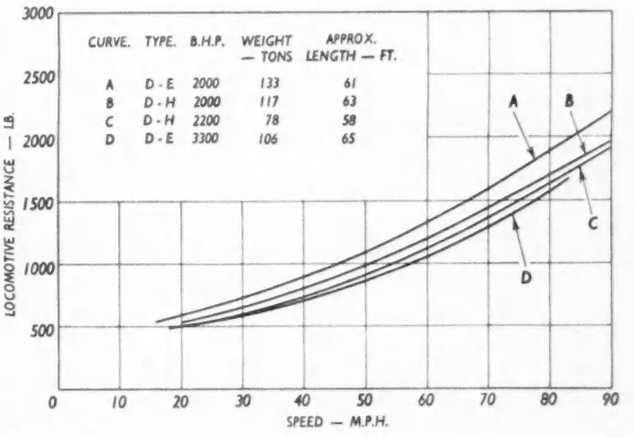
railway operation. He said, concerning this diagram : " Each line is the space-time relation of a train. The whole complex network shows the services provided to meet public needs within the limitations of the technical equipment. It reveals the traffic control. It signifies the veins and arteries of the enterprise. Yet each line can be precisely determined by the mechanics of the train. Formerly, whilst the traffic pattern remained uneventful in character and the technical equipment stable by nature, many of the functions of the mechanics of the train could be performed empirically and more or less passably. But when any novelty is about to be introduced, especially on a large scale, forward planning is impossible without the help of the mechanics of the train. It is absolutely essential in operation research, which is the only efficient way of obtaining maximum productivity of the enterprise at lowest cost, and of specifying technical equipment of the right type and the right power . . ."

The diagram, Fig. 1, relating to the main line of the Western Region between Paddington and Wolverhampton, is worth a close study for its own sake. It shows clearly the paths of the through express passenger trains leaving Paddington at 9 a.m., 9.10 a.m., 10.10 a.m. and 11.10 a.m., and trains running at similar schedules in the opposite direction, but it shows also the almost incredibly slow running demanded by the present time-table for some of the freight trains. One, for example, leaving Greenford at about 10.10 a.m. is no further than Princes Risborough at 3 p.m. in the afternoon ! There is no field of railway enterprise that offers greater financial rewards for increased productivity than the drastic acceleration of freight train services, and with the fitting of continuous brakes to all vehicles, and the possibility therefrom of safe running at considerably higher speeds, the basic data of train resistance established in experimental work, such as described by Mr. Ell, will be invaluable in the planning of entirely new time-tables. It should be emphasised, however, that Fig. 1 represents the planned time-table, on which daily running of the railway is based. The availability of precise data, both in respect of locomotive capacity and train resistance, enables time-tables to be planned so as to give greater margins between trains at junctions and other conflicting points, and so to give more liberal margins for recovery.

So far as locomotive power is concerned, the verifying of the basic tractive effort relations, by means of the controlled road system of testing, has been discussed many times previously in THE ENGINEER ; but for ready reference the diagram, Fig. 3, is included herewith, together with the accompanying " key," taken direct from Mr. Ell's paper. The resistances of rolling stock quoted are of considerable interest, and comparison with values obtained from some of the older empirical formulæ will indicate that a great deal has been done over the years to reduce the resistance of passenger stock.

Resistances of Current Passenger Stock

Speed, m.p.h.	Resistance, pound per ton
10	3·65
20	4·53
30	5·67
40	7·01
50	8·58
60	10·33
70	12·30
80	14·52
90	17·07


CURVE. TYPE. B.H.P. WEIGHT — TONS APPROX. LENGTH — FT.
A D-E 2000 133 61
B D-H 2000 117 63
C D-H 2200 78 58
D D-E 3300 106 65
LOCOMOTIVE RESISTANCE — LB.
3000 2500 2000 1500 1000 500
0 10 20 30 40 50 60 70 80 90
SPEED — M.P.H.
A
B
C
D

Curve reference	Type of locomotive	Nominal power, d.b.h.p.	Description	Weight tons	Approximate length, ft
A	Diesel electric	2000	" Southern " type	133	61
B	Diesel hydraulic	2000	" Western " type	117	63
C	Diesel hydraulic	2200	" Western " type	78	58
D	Diesel electric	3300	" Deltic "	106	65

Fig. 2—Resistance of locomotives

These values have been very thoroughly confirmed in many road tests.

It is significant of the changing times that when he comes to locomotive resistances Mr. Ell quotes figures only for non-steam types of locomotives. The total resistance on the level at any given speed V is obtained from the basic tractive relations as shown in Fig. 3.

$$R_e = P_r - \frac{p}{K} + W_e r_c$$

where

P_r = Rail tractive effort, pound.
R_e = Total resistance of locomotive, pound.
p = Actual tractive effort exerted on the trailing load, pound.
K = Ratio of trailing load to gross weight of train.
W_e = Weight of locomotive, tons.
r_c = Resistance of trailing load, pound per ton.

The diagram, Fig. 2, shows the appropriate figures for four modern types of locomotive.

Data for multiple-unit stock follow, and in this case Mr. Ell considers that the total resistance of such trains on the level is best reckoned as made up of the sum of three quantities :

(*a*) Depending upon the weight of the train.
(*b*) Depending on the number of vehicles.
(*c*) A constant per train, being the same for a solo car as for a nine-car set.

The accompanying table gives a series of values that have been used in the planning of a large number of new timings, and which have proved reliable in service :

Resistances of Multiple-Unit Trains

Speed, m.p.h.	r_m	r_w	r_0
10	2·82	17·0	150
20	3·28	29·4	166
30	3·78	48·4	210
40	4·30	72·4	300
50	4·90	102·0	450
60	5·52	136·5	640
70	6·18	176·0	860
75	6·52	198·4	972

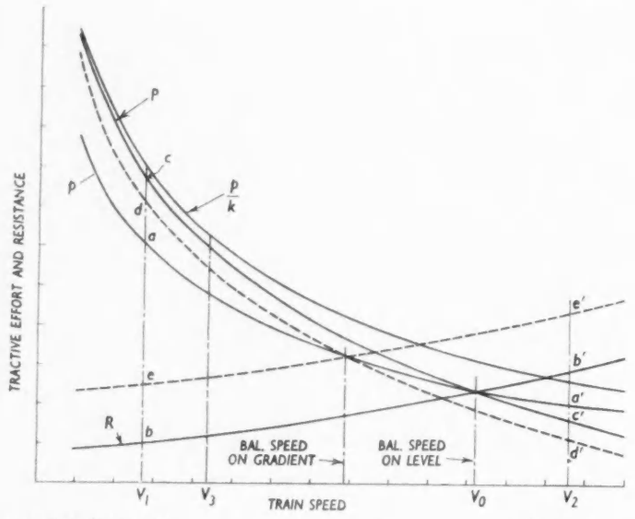
r_m = Factor depending on weight.
r_w = Factor depending on number of cars.
R_0 = Constant.

To obtain the total resistances of a train at any speed the following formula is applied :

$$\text{Total resistance} = Wr_m + Nr_w + R_0 \text{ lb}$$

where

W = Total weight of train, tons
N = Number of vehicles.



W_e = Weight of locomotive.
W_c = Weight of trailing load.
$n = \frac{W_e}{W_c}$.
$k = \frac{W_e}{W_e + W_c}$ = trailing : gross weight ratio.
F = Fuel rate.
V_0, V_1, V_2, V_3, &c. = Train speed.
r_c = Specific resistance of trailing load on the level.
r_e = Specific wind and track resistance of locomotive on the level.
$R = r_c \times W_c$ = Total resistance of trailing load on the level.
$C = r_e \times W_e$.
P = Equivalent drawbar tractive effort or drawbar tractive effort on the level at constant speed = rail tractive effort $- r_e W_e$.
p = Tractive effort on trailing load or traction drawbar tractive effort (trac. d.b.t.e.).

Residual Forces *bc*, *b'c'*, &c.

On Level :
ab, *a'b'* &c., acceleration force on trailing load.
ac, *a'c'*, &c., acceleration force on locomotive.
Locomotive and trailing load have same acceleration.

Therefore $\frac{ab}{ac} = \frac{a'b'}{a'c'} = \frac{W_c}{W_e} = n$.

On Gradient :
cd, *c'd'* Gradient component of locomotive.
eb, *e'b'* Gradient component of trailing load.

Therefore $\frac{cd}{eb} = \frac{c'd'}{e'b'} = \frac{W_e}{W_c} = \frac{1}{n}$.

ad, *a'd'* Acceleration force on locomotive.
ae, *a'e'* Acceleration force on trailing load.
Locomotive and trailing load have same acceleration.

Therefore $\frac{ae}{ad} = \frac{a'e'}{a'd'} = \frac{W_c}{W_e} = n$

Thus p is not qualified by gradient and acceleration. Consider a given fuel rate F and speed V_3 as

$$W_e = nW_c, \quad R = nC \text{ and } k = \frac{n}{n+1}.$$

$$p = P - (P - nC)\frac{W_e}{W_e + W_c}$$

$$= P - P\frac{W_e}{W_e + W_c} + nC\frac{W_c}{W_e + W_c}$$

$$= P\left[1 - \frac{W_e}{W_e + W_c}\right] + nC\frac{W_c}{W_e + W_c}.$$

But $1 - \frac{W_e}{W_e + W_c} = k$ and $W_e = nW_c$.

Therefore $p = Pk + Ck$.

Therefore $p = k(P + C)$ . . . . . (1)

NOTE :
(i) This result is independent of n and therefore holds for all values of n.
(ii) Thus for a given fuel rate and speed, P and C are constant, $p \propto k$ from (1)

Therefore $\frac{p_1}{k_1} = \frac{p_2}{k_2} = \frac{p_3}{k_3}$ . . . . . .

(iii) This may be extended to traction d.b.h.p. and fuel/traction d.b.h.p./hour as follows :

traction d.b.h.p. $\propto p \propto k$

fuel/traction d.b.h.p. hour $\propto \frac{1}{p} \propto \frac{1}{k}$.

(iv) When $r_e = r_e C = W_e r_e = W_e r_s$
$p = k(P + C) = k(P + W_e r_s)$
$= k \times$ rail t.e.

When $r_c > r_e$
$p = k[\text{rail t.e.} - W_e(r_c - r_e)]$.

Fig. 3—Basic tractive effort relations

Freight vehicles constitute a much more complex problem, due to the variation in size, weight and shape of stock. Furthermore, the loading is to some extent unpredictable, and the planning of train schedules to the same degree of precision as with passenger trains is hardly a practical proposition. But because of the great need to improve freight train services, and the fact that the resistance of freight stock is in general considerably higher than that of passenger, weight for weight, a determined effort has been made to provide some data on which future planning can be based. Mr. Ell has derived the family of curves shown in Fig. 4 for a total train load of 520 tons, including brake van. These curves were obtained from road tests of a series of trains, all of the same total weight, but of different composition. For trains of similar composition and weight the total resistance can be taken as directly proportional to the weight. The graph references *A* to *K* on Fig. 4 relate to trains as follows :

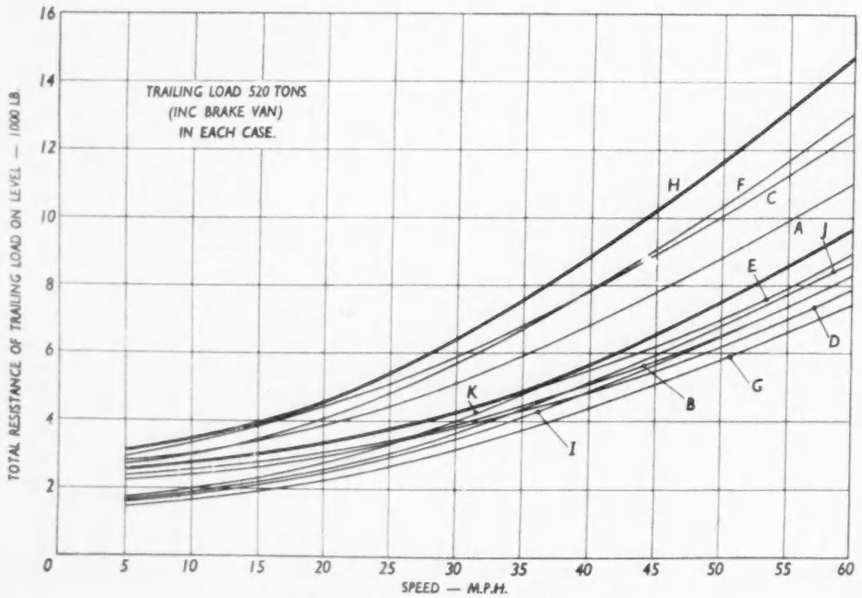


Fig. 4—Resistance of freight vehicles

Curve	Description	Weight/vehicle, tons	Class of traffic
A	Empty vans	7·9	—
B	Loaded vans ...	11·6	3
C	Empty vans	6·0	—
D	Loaded vans ...	13·0	2
E	Loaded vans ...	10·0	3
F	Empty wagons ...	7·5	—
G	Loaded wagons ...	23·5	1
H	Empty wagons ...	6·0	—
J	Loaded wagons ...	16·0	1
J	Loaded wagons ...	13·0	2
K	Loaded wagons ...	10·0	3

The envelope curves—shown in thick lines in the diagram Fig. 4 for both empty and loaded wagons—give what might be termed as an overall result that could be used in general calculations. For a train of 520 tons of loaded vehicles the result is as follows.

Basic Schedules Maximum Power, Point-to-Point Times—minutes

| | Paddington | | |

Vibrating-Wire Strain Gauge for Long-Term Internal Measurements in Concrete

By F. P. POTOCKI, B.Sc.*

A description is given of a cheap acoustic strain gauge of low overall longitudinal stiffness, developed for measuring long-term changes of strain in concrete road slabs. The instrument is 5½in long with flanges at each end of 1½in diameter. The vibrating wire is attached to these flanges and is enclosed within a "Perspex" tube of ¼in external diameter. The wire is plucked electrically by a recurrent pulse applied to an energising coil attached to the "Perspex" tube, and the vibration of the wire is observed by the signal it generates in this coil. The application of tension between the flanges raises the strain in the wire and its frequency of vibration. The change of frequency is observed by comparing the signal derived from the gauge with that of a reference wire, the tension in which is adjusted by a micrometer. To eliminate spurious effects, the vibrations are compared with those of a tuning fork. Tests show that the gauge works reliably in concrete and has an accuracy of 0·5 microinch per inch or ±2 per cent. The article describes the many tests to check the working and reliability of the gauge, and shows it to be suitable for long-term measurements of shrinkage in concrete under field conditions, for determining the thermal expansion of concrete, and for measuring static strains due to thermal warping and other slowly varying phenomena. The gauge costs about £1 10s. to produce and is thus considered to be sufficiently cheap for embedding in road slabs where recovery is impossible.

Introduction

At the Road Research Laboratory, measurements are being made of all the strains to which concrete road slabs are subjected in order to obtain data for design purposes. Such slabs suffer a combination of the dynamic strains generated by vehicles moving over them and the slowly varying strains due to restraint of temperature warping, subgrade friction opposing thermal movement, shrinkage and creep. Resistance strain gauges have been used at the Laboratory for measuring dynamic strains and those that vary during daily cycles,[1] such as thermal warping, but they are not usually sufficiently reliable for measuring strains over periods of many months, whereas a gauge of the vibrating-wire type is more reliable although not suitable for dynamic work. The presence of any rigid device within the concrete upsets the distribution of strain : this disturbance was minimised with the resistance strain gauges by making their overall elastic properties similar to those of the concrete. For long-term measurement of shrinkage and creep, however, it seems essential that the gauge should not affect these phenomena and a low overall Young's modulus seems desirable.

This paper describes the development of a cheap strain gauge of the vibrating-wire type for measuring long-term internal strains in concrete road slabs. The gauge has a very low overall elasticity in order to cause minimum interference with the phenomena it has to measure. Cheapness is an essential factor because it is usually impossible to recover strain gauges from road slabs. Some gauges have been operated satisfactorily for more than a year.

The vibrating-wire gauge or "acoustic" gauge works on the principle that variation of the tension between the ends of a steel wire changes its frequency of vibration. Much work on such instruments has been done in Britain[2, 3] and abroad,[4–7] principally by Maihak in Germany. The gauges described have been found to be sufficiently stable for measurements over long periods, but those obtainable commercially are either designed primarily for attachment to the surface of structural members or are too costly to be embedded in road slabs.

* Road Research Laboratory, Department of Scientific and Industrial Research.

Description of Gauge

The new acoustic strain gauge consists basically of a 0·010in diameter silver-plated steel piano wire stretched between two steel flanges (see Fig. 1). When buried in concrete, the strain existing between the two flanges changes the tension and frequency of vibration of the wire. The body of the gauge consists of "Perspex" tubing, 5½in long by ¼in outer diameter ; this provides sufficient lateral stiffness to protect the vibrating wire from damage while being embedded in the concrete and to maintain the tension in the wire during this operation. Fig. 2 shows details of the flanges and of the devices for clamping the wire. Each end of the wire is clamped centrally in the flange by a plug and two grub screws, the plug having a longitudinal groove to locate the wire ; experiments have shown that this clamping is an important factor in attaining long-term stability.

The wire is started in vibration by electrical plucking and its subsequent vibration is measured electrically, both operations being performed via the energising coil shown in Fig. 1 at the centre of the "Perspex" tube. This is a 150-ohm coil of the type used in head-phones ; it is fitted into a recess 0·08in ±0·005in deep in the centre of the housing and fixed with "Araldite D." By this arrangement, the distance between the end of the coil and the wire is made between 0·040in and 0·050in ; slight variation of the distance has a negligible effect on sensitivity. "Araldite D" is also used to attach the flanges to the tube, to seal the unit after the tension of the wire has been adjusted to give a suitable frequency of vibration, and to protect the junction between the leads and the coil. The unit has negligible longitudinal rigidity and the relative movement of the flanges corresponds with the strain of the concrete. The frequency of the vibrating wire under any condition of strain is compared with that in a similar wire in which the tension is adjusted by a micrometer screw. When such comparisons are made with the gauge initially unstrained and then strained, the difference between the micrometer readings shows the change of strain in the gauge wire.

The steel wire within the strain gauge is set in vibration by an alternating-current plucking-pulse derived from an oscillator and fed to the energising coil at regular intervals.

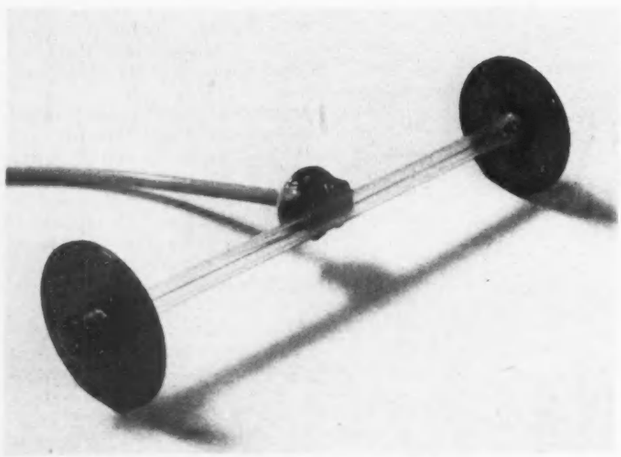
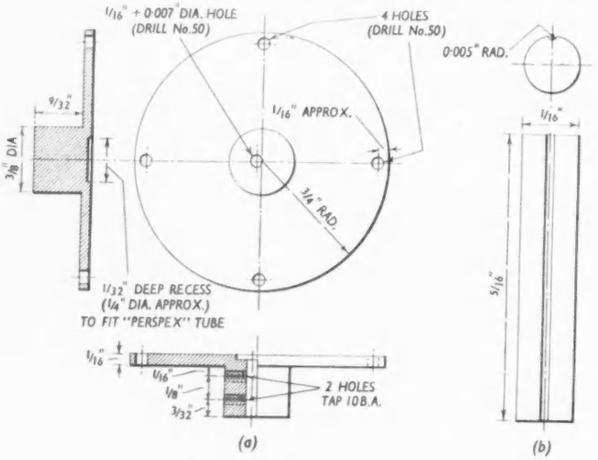


Fig. 1—Low-rigidity acoustic strain gauge



(a) Details of flange.
(b) Steel plug for clamping vibrating wire.

Fig. 2—Details of acoustic gauge

The rate of repetition of these pulses is adjustable and a new pulse is applied as soon as the free vibration has died away. During the period between successive pluckings, the movement of the vibrating wire close to the energising coil generates an electric signal in it which is amplified and fed to one pair of deflecting plates of an oscilloscope (see

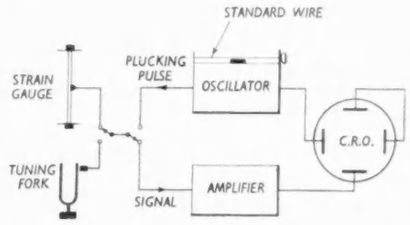


Fig. 3—Block diagram of the measuring apparatus

Fig. 3 and Fig. 4). The reference wire forms part of the circuit of the oscillator and is maintained in continuous vibration. The signal from its circuit is fed to the other pair of deflecting plates of the cathode-ray tube and the tension in the reference wire is adjusted by the micrometer until the ellipse seen on the cathode-ray screen becomes stationary. The working range of the reference wire is from 500 c/s to 850 c/s and covers the range of strains likely to be encountered in measuring strains in concrete.

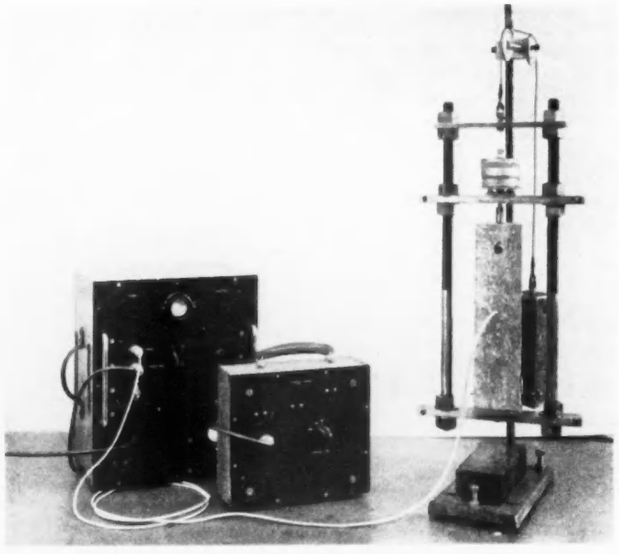


Fig. 4—Apparatus used to compare shrinkage of concrete measured by micrometer and by internal acoustic strain gauge. The larger case on the left contains the oscilloscope and reference wire and the smaller case contains the tuning forks

To correct for any variation of the zero of the reference wire, its vibrations are matched against the signal from a tuning fork immediately after the reading on the strain gauge. The correction is linear, involving simple addition or subtraction of the micrometer reading. There is also a linear relation between strain and the micrometer reading, because the matching frequency of the strain gauge and reference wires is only an intermediate step in comparing their strains. To obtain high accuracy, the measuring apparatus and the reference wire must be kept at a reasonably constant temperature for about half-a-minute, while the micrometer attached to the reference wire is read when its frequency is, first, adjusted to that of the acoustic gauge, and, second, adjusted to correspond with that of one of the tuning forks. When the apparatus is used in the open, it is covered by a blanket to keep out draughts.

The reference wire plays a secondary part in relating the frequency of the acoustic gauge to that of the tuning fork. The absolute values of the micrometer readings do not matter, therefore, and it is only necessary that the sensitivity of the reference wire shall be known when readings are made. Because the equipment is used frequently under field conditions, precautions are taken to check whether changes of the sensitivity of the reference wire occur due to mechanical damage or dirt (such as metallic filings) adhering to the wire. The scale interval is therefore checked periodically against two of the tuning forks (700 c/s and 800 c/s) and the sensitivity of the reference wire relative to that of the gauge is obtained by the calibrating technique outlined below.

Calibration

The position of the nodes of the vibrating wire depends on the mass and stiffness of the supports.[8] When the nodes do not coincide with the points of attachment of the wire, the effective length is changed and this alters both the natural frequency and the sensitivity. The reference wire is held in a steel frame, but even so, the sensitivity changed by 5 per cent when 2 lb weights were attached to the frame near the clamping points. To minimise this effect where the strain gauges were concerned, therefore, the initial calibrations were made with gauges actually embedded in concrete. Four concrete prisms were cast, each 16in high by 2in by 1½in cross-section and containing a single acoustic strain gauge on the longitudinal axis at the centre of the prism. A Martens' mirror extensometer of 6in gauge length was attached to each beam in turn with its knife edges close to the flanges of the strain gauge which just reached the surface of the concrete on the 16in by 2in faces. Each flange was 5in from the end of the prism in contact with the platen of the testing machine, so the distribution of stress across the section of the prism was fairly uniform but for the disturbing influence of the flange itself. The arrangement of the equipment is shown in Fig. 5. Each beam was tested in compression and the readings of the two optical extensometers agreed to better than 5 per cent in all cases. The readings of the acoustic gauges are given in Fig. 6, plotted against the averages of the pairs of readings of the optical gauges, and the slopes of the four lines agreed with each other to within ±2 per cent. Where great accuracy is not required, therefore, a gauge made as described in this paper should have a sensitivity of $2{\cdot}06 \times 10^{-6}$in per inch per scale division; it would thus be unnecessary to calibrate individual gauges.

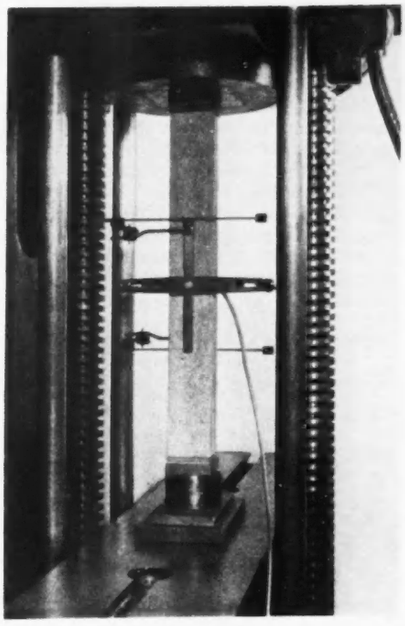


Fig. 5—Calibration of acoustic gauge against an optional extensometer (strain gauge embedded in concrete)

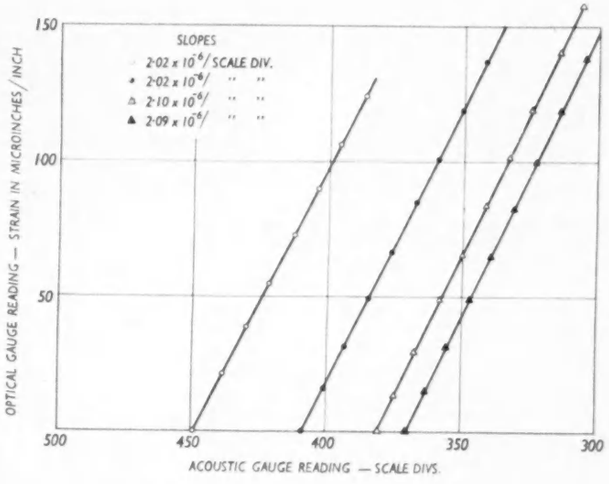


Fig. 6—Calibration curves for four acoustic strain gauges

Length of Leads

When strain measurements are made on the road, it is frequently necessary to employ long wires to connect the strain gauges to a central point. Experiments have shown that increasing the length of lead from 10ft to 500 yards has no effect on accuracy of reading, or stability, and has a negligible effect on signal strength. It seems likely that even

greater lengths of lead might be used without affecting the equipment.

Effect of High Temperatures

Acoustic gauges have been used to measure the shrinkage of concrete specimens which are heated in an oven for fairly long periods. To check the behaviour of the low-rigidity (" Perspex " body) acoustic gauge under such conditions, four concrete beams each containing a gauge, were heated in an oven at 100 deg. Cent. for sixteen hours. The gauges sustained no damage and were satisfactory at the end of the test.

Coefficient of Thermal Expansion of the Vibrating Wire

The coefficients of thermal expansion of steel and concrete are approximately equal, hence the thermal expansion of the wire in a gauge embedded in concrete should equal that of the concrete and give no resultant change in strain. When the strain to be measured is small, however, and the temperature change is large, the difference in expansion of the wire and the concrete becomes important and the temperature coefficient of the wire used in the strain gauge must be determined. To do this, a strain gauge was clamped by four " Invar " rods (see Fig. 7).

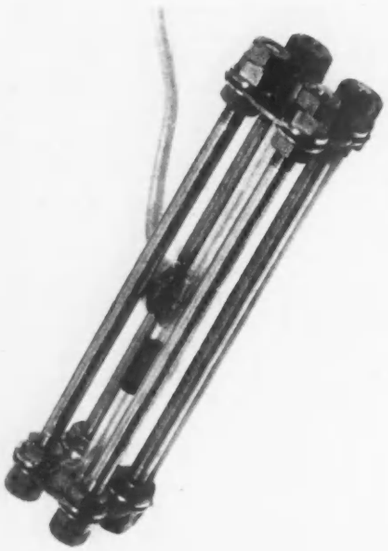


Fig. 7—Arrangement for determining temperature coefficient of acoustic gauge. The gauge is held in a frame formed by four " Invar " rods

Part of the " Perspex " body of the gauge was cut away and replaced by rubber tubing to prevent the " Perspex " affecting the results. The clamped gauge was subjected to a temperature change of 50 deg. Cent. and strain readings were made : a linear relation occurred between temperature and strain (Fig. 8) and, allowing for the expansion of " Invar," which was assumed to be 1×10^{-6}in per inch per deg. Cent., the thermal expansion of the wire was found to be $9{\cdot}7\times10^{-6}$in per inch per deg. Cent., and the corresponding correction on the micrometer scale was 4·7 divisions per deg. Cent. This experiment assumed that the special gauge had the same rigidity and sensitivity as one cast in concrete. The theoretical error due to the change in tension of the wire is $0{\cdot}5\times10^{-6}$in per inch for a strain of 4×10^{-4}in per inch and has been neglected. Thermal strains can therefore be eliminated by using the correction factor $(a-9{\cdot}7\times10^{-6})$ per deg. Cent., where a is the coefficient of expansion of concrete.

Adjustment of Zero Frequency of Gauge for a Specific Experiment

The " Perspex " body of the acoustic strain gauge has a high coefficient of thermal expansion and, consequently, a temperature change of 25 deg. Cent. will cause the frequency of vibration of the wire to vary throughout the whole range of the measuring instrument. The gauge, therefore, is unsuitable for measurements in free air and has been devised solely for measuring internal strains in concrete. When the concrete has set, the metal flanges of the gauge are gripped and the " Perspex " tube plays no further part in the behaviour of the gauge : the effect of a temperature change becomes negligible, as was shown in the previous section, or corrections can be easily applied.

Because the tension of the vibrating wire has to be adjusted before the gauge is inserted into the concrete, the change of strain to be expected must be estimated (shrinkage of concrete may well cover about one-third of the range of the instrument), together with the temperature of the concrete at setting, because it will affect the initial readings of the gauge when a complete study of shrinkage is made. When allowance is made in this way, the subsequent strains are within the working range of the instrument.

Damage to Gauges Under Field Conditions

The gauges, having " Perspex " bodies, are somewhat fragile and liable to mechanical damage. To check their behaviour under field conditions, and to make strain readings, twenty-four gauges were cast into experimental concrete slabs laid as part of a full-scale road experiment. Two gauges were damaged out of the first group of four, but when the construction staff were prevented from walking over the uncompacted concrete containing the gauges, the remaining twenty worked satisfactorily.

Check on Long-Term Stability

To check the performance of the vibrating wires within the acoustic gauges and the ancillary equipment, two gauges were assembled with steel bodies and readings were taken over a period of a year. The same thermal coefficients of expansion were assumed for the two steel bodies and the piano wire and the variation of the readings during this period was less than $\pm1\times10^{-6}$in per inch, i.e. comparable with the minimum strain to be read with gauges of this type.

Check on Performance of Acoustic Gauges Used to Measure Internal Strains in Concrete

Four separate sets of tests were made to check the performance of the acoustic gauges made with " Perspex " bodies when used to measure internal strains in concrete :

(1) Shrinkage tests were made on beams in accordance with B.S. 1882 : 1952. Part 16, and the readings obtained with the specified mechanical gauge were compared with those of the acoustic gauges.

(2) Three identical beams were permitted to shrink over a period of two months and the readings obtained by acoustic gauges were compared.

(3) During flexural tests on a concrete beam, readings taken on an acoustic gauge subjected to tension were compared with those of one in compression.

(4) Acoustic gauges, both naked and embedded in concrete, were operated under water.

All the tests showed that the acoustic strain gauge was reliable and capable of measuring internal strains, particularly those due to shrinkage. Details of the various tests are given below.

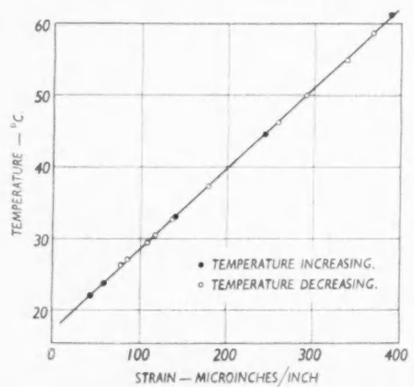


Fig. 8—Temperature calibration of piano wire (0·010in diameter, silver plated)

(1) Shrinkage Tests—Comparison With Technique Recommended in B.S. 1882 : 1952 Part 16

Six concrete specimens were cast, each being 12in long by 3in square, and three of them contained an acoustic gauge placed centrally along the longitudinal axis. After curing for seven days in moist air, ¼in diameter steel balls were attached to the centre of each 3in square face for subsequent measurements of change in overall length;

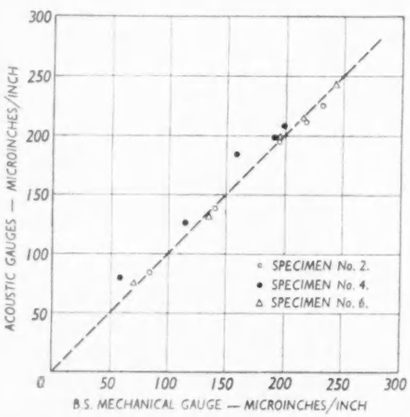


Fig. 9—Comparison between readings from acoustic gauges and shrinkage strains measured by B.S. apparatus on three 3in by 3in by 12in concrete specimens

the specimens were then cured in water for fourteen days. Immediately after removal from the water, the overall length of each specimen was read by the micrometer equipment specified in Fig. 9 of B.S. 1882 and the acoustic strain gauges were also read. The specimens were then heated to 50 deg. Cent. in an oven for forty-four hours and, after cooling, the measurements of overall length and strain were repeated. The micrometer could be read to half a division, i.e. to 0·00005in, enabling the change in length of specimen to be measured to an accuracy of 4 microinches per inch, which should be compared with the accuracy of 0·5 microinch per inch obtainable with the internal acoustic gauge.

Dimensional changes of the specimens were measured by both methods at the end of each of five periods of heating to 50 deg. Cent. for forty-four to fifty hours, by which time constant length was attained. Fig. 9 shows the readings obtained by the acoustic gauges plotted against those obtained by the micrometer, using the British Standard

apparatus, the results being expressed as strains in both cases. Good agreement occurred between the two sets of results with specimens Nos. 2 and 6, while the line relating to specimen No. 4 (not drawn in) would be parallel to, but above, that relating to the other specimens. This upward displacement of the line for specimen No. 4 was probably due to an error in the initial measurement of length. The agreement between the strains measured by the acoustic gauge and the British Standard shrinkage apparatus indicates that the acoustic gauge is capable of measuring the shrinkage of concrete. The acoustic gauge gives a greater reading accuracy for measuring laboratory specimens than does the apparatus recommended in the British Standard, and it is also suitable for shrinkage measurements on road slabs *in situ*.

The "initial drying shrinkage" was obtained by comparing the initial and final lengths of the specimens, as specified in B.S. 1882 and, when expressed as a percentage reduction of length, was :

Specimen No.	Percentage change in length determined by	
	Technique outlined in BS. 1882	Internal acoustic gauge
1	0·022	—
2	0·0235	0·0224
3	0·0205	—
4	0·020	0·0210
5	0·023	—
6	0·024	0·0242

The values of the initial drying shrinkage obtained by the two methods were in good agreement, while reasonable agreement occurred between the results in each group. These results indicate that the shrinkage was not affected by the presence of the internal strain gauges.

(2) Comparison of Shrinkage of Three Beams

Three identical beams, each 20in long by 1½in by 2in, were simultaneously cast and vibrated, after which they were placed in a thermostatically controlled room having an atmosphere of low humidity. Each beam contained an acoustic gauge at its centre with its axis on that of the specimen. The gauges were read at intervals over a period of two months, and the results are shown in Fig. 10. The differences between the readings were about ±2 per cent and show that the gauges behaved satisfactorily.

(3) Flexural Test on Beam Containing Acoustic Gauges

In measuring the slowly varying strains arising in road slabs due to thermal warping, expansion and contraction, shrinkage and creep, the gauges will have to record both tensile and compressive strains. The main purpose of the flexural test was, therefore, to compare the behaviour of acoustic gauges tested in tension and compression.

Three acoustic gauges ("Perspex" tube type) were cast in a concrete beam 7ft long by 12in wide by 10in deep.

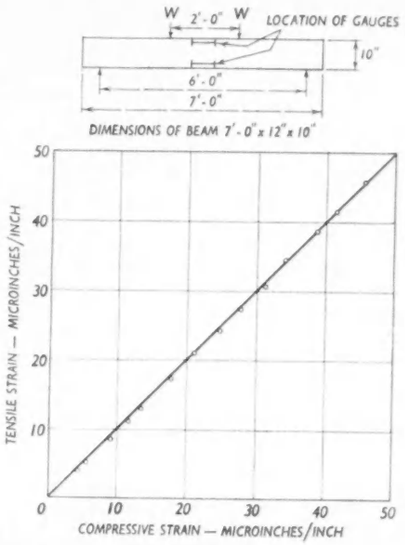


Fig. 11—Comparison on tensile and compressive strains measured by acoustic strain gauges cast in a concrete beam subjected to uniform bending

All gauges were set parallel to the 7ft by 12in faces, one ¾in below the upper surface, one on the axis of symmetry, and one ¾in above the lower surface. The gauges were set in the centre of the length of the beams and on a vertical plane through its axis. When the beam was subjected to flexure, the upper gauge was subjected to compression and that near the underside to tension. Fig. 11 shows the readings of the gauge subjected to tension plotted against those of that in compression ; good agreement betweent he results occurred, indicating that the low-rigidity acoustic strain gauge is equally satisfactory for measuring tensile and compressive strains.

(4) Immersion of Acoustic Gauges in Water

A low-rigidity acoustic gauge, not embedded in concrete, was immersed for a month under a 1ft head of water and it continued to work satisfactorily.

A concrete beam, 16in long by 1½in by 2in, containing an acoustic strain gauge placed centrally on its axis, was permitted to dry until a shrinkage strain of 3×10^{-4}in per inch had been attained, and was then immersed in water under a 1ft head. The readings obtained in the subsequent two hours are shown in Fig. 12 and indicate how the gauge performed as the concrete swelled on re-wetting. The smooth curve indicates that immersion under water had no significant effect on the electrical characteristics of the instrument.

Advantages of New Type of Acoustic Gauge

The advantages of the low-rigidity acoustic strain gauge described in this paper are :

(1) Low cost of manufacture—approximately 30s.

(2) Simplicity—results are easily computed because of linear relation between strain and scale reading.

(3) Readings are quickly obtained and no special skill is needed to operate apparatus.

(4) High reading accuracy—of order of ½ microinch per inch.

(5) Except when exceptionally great accuracy is needed, it is unnecessary to calibrate each gauge.

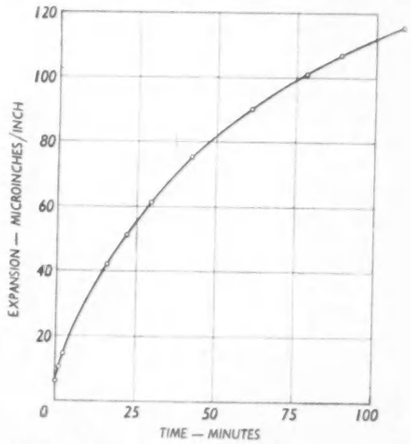


Fig. 12—Expansion of concrete immersed in water

(6) Equal reliability in tension and compression.

(7) Capable of recording shrinkage strains.

(8) Works with long cables—up to 500 yards found to be satisfactory.

(9) Gives reliable readings over long periods—probably several years.

Acknowledgments

Thanks are due to Mr. Chaplin, of the Building Research Station, for helpful suggestions in the initial stages of development of the apparatus. The work described in this paper was carried out as part of the programme of the Road Research Board of the Department of Scientific and Industrial Research. The paper is published by permission of the Director of Road Research.

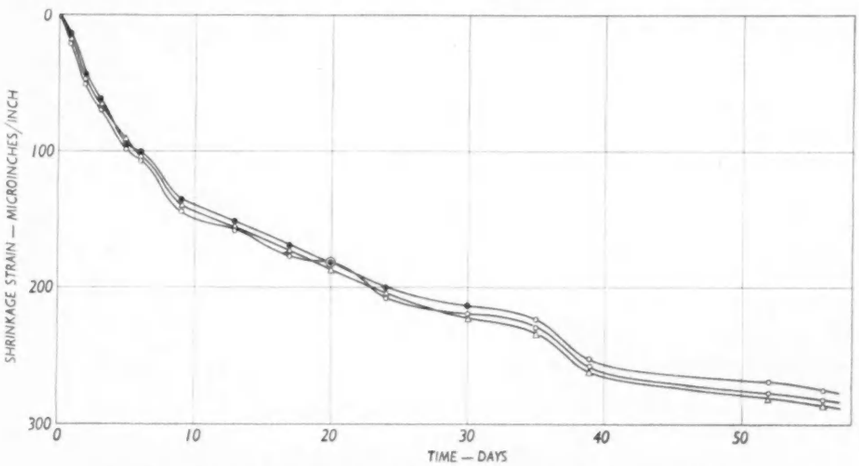


Fig. 10—Variation of shrinkage strain of three separate concrete beams with time

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LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

TRAINING FOR DESIGN

SIR,—Your contributor, Hugh Clausen, in the December 5 issue of THE ENGINEER, mentions many points in the training of designers with which designing engineers generally will agree.

He is surely off the beam, however, when he accuses the Draughtsmens' Association of creating ill feeling and making the job uncongenial for academically trained potential designers. Academic training is certainly not the be-all and end-all of designing.

The present low rates of pay and the lack of esteem with which draughtsmen are held obtain, and continue, in spite of the persistent efforts of the Draughtsmens' Association to better them.

He does not criticise the association of the manufacturers in the forms of the various federations, but merely mentions the workers associations, which were created and continued to grow because some of the managements and the federations in industry persistently refuse to recognise the importance and the value of the designers.

The real down-to-earth reason why any ambitious person will not enter the designing and draughting field is the fact that, for good men it is a dead end job. Good men are not allowed to move up the ladder of promotion. Another most important reason is the low remuneration offered for the job which the author admits is so important.

He states that the universities are not teaching design. The design teacher must be a practical designer himself, and it is doubtful if the younger members of the university and college staffs have had much practical training in this field.

The best teacher is " practical experience."

It is true that a good designer is the man in authority, and that what he says goes. Because of this it follows that he must be 100 per cent practical and if necessary able to go out and make what he designs.

The writer fully agrees with Mr. Clausen regarding the present attempts to shorten the training period for engineering designers, and one of the fundamental activities of the associations which he decries, is to encourage and help in the training which he says is so fundamental to our future prosperity.

R. A. MILLER

Scunthorpe, Lincs,
December 9, 1958.

Book Reviews

Transients in Electrical Circuits. By G. V. Lago and D. L. Waidelich. The Ronald Press Company, 15, East 26th Street, New York 10, N.Y. Price 7·50 dollars.

THE authors are Professor and Associate Professor of Electrical Engineering in the University of Missouri and have written the book specifically for junior and senior students. They are to be complimented on a clear, concise and logical development of the subject. The book can be recommended also to older engineers who want to re-establish contact with the subject of electrical transients as with the increase in the use of automatic devices of all kinds a knowledge of transient performance cannot be too highly stressed. A particularly pleasing feature is the generous use of illustrative examples throughout the book and the inclusion of a series of graduated problems. Obviously in a subject of this kind some background of mathematics is essential. Provided the reader has some acquaintance with differential and integral calculus he should have no difficulty in following the text, as the subject is not developed to the extent that partial differential equations are required in the treatment.

In the first four chapters classical methods only are used to treat circuits with up to two storage elements. Consideration is given also to electrical circuit theory and examples illustrate duality of circuits, Thevenin's and Norton's Theorems, the use of mesh and nodal equations, &c. With this background the reader is introduced next to Laplace Transforms and the advantages of this method of dealing with initial conditions is illustrated. Consideration is then given to the factoring of algebraic polynomials for their zeros and attention is confined only to the methods of Lin and Horner, but these are adequate for the purposes of the book.

After a chapter on the treatment of mutual inductance the theory developed so far is applied to the determination of transients with alternating-current sources. This is simple, direct and well treated. Solutions are obtained first by determining the steady state component by the usual a.c. method and the form of the transient component from the differential equation. By imposing the correct initial conditions the arbitrary constants can be determined. Solutions for the same driving functions are then obtained by using Laplace Transforms and show the elegance of this method. This leads to the treatment of a variety of driving functions accompanied by examples illustrating the steady state response of circuits to various non-sinusoidal wave shapes.

Consideration is then given to mechanical and electro-mechanical systems and their electrical analogues and to electrical machines as composite structures. This background is then used for an introductory treatment of control systems. For the purpose intended it is adequate. The last two chapters are devoted to Fourier series and integrals and act as an introduction to the application of the latter in circuit theory.

The Appendix contains a list of fourteen Fourier pairs and thirty-two Laplace Transform Formulas.

The Analysis of Grid Frameworks and Related Structures. By ARNOLD W. HENDRY and LESLIE G. JAEGER. Chatto and Windus, Ltd., 42, William IV Street, London, W.C.2. Price 50s.

THE interest that has been shown in grid frameworks has been largely stimulated by the abnormal indivisible loads for which many bridges have to be designed. This book is probably the first in this country entirely devoted to the subject, although the Cement and Concrete Association has published many excellent papers and design charts which have become almost standard tools in the hands of the prestressed concrete bridge designer.

The subject is treated generally, although naturally a large part is devoted to the bridge deck problem. It is divided into four parts. First, a design section, which, by means of examples, solves many of the simpler problems with only a minimum of explanation of the method ; secondly, an analytical section which explains the theory in detail and derives the coefficients used in the solution of the problems ; thirdly, a section describing experimental work with which the theory is compared, and, finally, an appendix giving basic functions, formulæ and graphs for distribution coefficients and formulæ for transverse moments.

All practical solutions of these problems are only obtained by making certain assumptions. In the authors' method the transverse members are replaced by a uniformly spread medium, the longitudinal members being left discrete as opposed to the Massonet and Guyon approach. This leads to a little complication when more than six longitudinals are considered since this is the maximum number for which the calculations and distribution coefficients have been tabulated. The distribution of loads is obtained using harmonic analysis in the case of simply supported members, and basic function analysis in the case of the more complicated structures such as fixed ended slabs, interconnected portal frames, &c. Their solution particularly for the transverse bending moment will not be so popular with those engineers concerned only with simply supported cases since it is given in terms of equations and is not readily graphed. The book should appeal to engineers in particular since a large number of cases can be solved with only a little knowledge of the method. The second part should appeal to the more advanced designer and to those who are unfamiliar with this powerful method of analysis.

The book as a whole is to be welcomed for a clear exposition of a method of tackling grid problems which occur in a number of cases in buildings as well as in bridge work, particularly at a time when engineers are more conscious of the integrated behaviour of structures.

Glass Engineering Handbook. By E. B. SHAND. Second edition, 1958. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 77s. 6d.

THE copyright of this book is reserved by Corning Glass Works, Corning, New York, but the data in it are not restricted to the products or researches of that company, although much of the material must necessarily originate there. It is stated in the introduction that the book is written to have a first appeal for designers and engineers who do not necessarily have a specialised knowledge of glass, with the result that certain parts, such as the chapters on manufacture, are too brief to be of interest to a glass specialist, but are probably adequate for the person not directly involved to have a sufficient appreciation of the process to get a feeling for the material.

The book comprises four sections, with twenty-four chapters and two appendices.

It ranges through glass technology, glass manufacture and applications, and has an extended portion devoted to fibrous glass. Much valuable data are collected in these chapters in the form of tables, and some of it is not easily available in other publications. Since the book treats of glass as an engineering material the author has included formulæ on the calculation of stress distribution in engineering structures, which, of course, is available in other books, but for convenience is reproduced here. It is a matter of opinion whether it would have been better to omit this, thereby shortening and presumably cheapening the volume, since the engineering reader to whom the book is addressed might be assumed to know where to find this information. In our view some of the sections, as, for example, Refraction, are either too abbreviated to be easily understood by the engineer, or, on the other hand, too extensive to interest the expert.

The book is well produced, with clear diagrams and tables, and as a reference book can be recommended to anyone who needs to make calculations involving the physical properties of glass. One particularly valuable section is that which deals with manufacturing tolerances and glass design. The glass maker often feels that the engineer imposes on him tolerances which are impracticable, and the tolerances and limitations indicated in this book should, if properly applied, go far to remove this objection.

Gas Turbines for Aircraft. By A. W. JUDGE A.R.C.S., D.I.C., Wh.Sc., A.M.I.Mech.E., M.I.A.E. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 60s.

ON receiving this volume we spent some time assuring ourselves that it was a first edition : it is difficult to believe that there still exists a need for introductory texts on the subject named in the title. On studying the contents, however, we ceased to debate this theme : for this book falls far short of the standards indicated by its price. An issue of very great interest at present is the potential of the by-pass turbojet, and the picture has been very badly confused because characteristics of the one and only example have been attributed to the whole class : here, then, is an excellent instance where elucidation would be valuable. The treatment starts well by comparing pure and by-pass jets for the same airflow, thus rendering changes in drag and engine size secondary, and reaches the accepted conclusion that for the same thrust the pure jet will burn slightly less fuel and weigh considerably more. Without any assumptions as to the nature of the aeroplane, it is then stated that with by-pass engines its range will be greater ! This assertion, which might well be true for a trans-continental machine, is later applied to transatlantic missions, without any reservations whatever : however, by this stage the basis of comparison has implicitly been abandoned, with the statement that " for the same thrust and combustion temperature " the exhaust velocity and, hence, noise output of the by-pass is lower. The treatment is finally condemned by being confused with the ducted fan.

Even the descriptive parts of the text are exceptionable : it is stated that the Bristol " Theseus " had some original design features, but nowhere explained that its highly improbable appearance is due to provision for a heat exchanger. In the more involved philosophy of the torque-limited compound or " supercharged " turbo-prop, it is never observed that the one real difference, other than the behaviour of the fuel system black box, is a smaller reduction gear. When discussing the Rolls-Royce " Tyne " it is stated that the by-pass system is " unnecessary " for turbo-prop engines, thus establishing that the fundamentals of propulsion are not clearly understood.

Ecoulement d'un fluide entre deux plans parallèles, contribution à l'étude des butées d'air. By R. COMOLET. Publications Scientifiques et Techniques du Ministère de l'Air, No. 334. Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price : Ffr.1100.

PROBLEMS of viscous flow between parallel planes are two-dimensional. Under certain simplifying assumptions, the Stokes-Navier equations can be solved or approximated. Experimental work to verify the formulæ so found has not always met with equal success. In the present work the author describes theoretical as well as experimental researches which he carried out. The simplified equations are integrated for those cases following a polytropic transformation. If then the (usually neglected) inertia terms are introduced, one obtains solutions of much greater theoretical importance, particularly interesting for divergent flow. The radial divergent flow of a viscous incompressible fluid is studied. Applications of the solutions to various cases are described.

Messwandler. BY WILHELM BEETZ. Verfahrens- und Messkunde der Naturwissenschaft, Heft 10, Brunswick : Friedr. Vieweg and Sohn, (20b) Braunschweig, Burgplatz 1, German Federal Republic. Price DM.7.80.

THE present booklet is concerned with conveying to the general technical reader an all-round picture of the present state of measurement transformers. It brings up to date the information on the subject contained in the first edition, published in 1950. A bibliography of books and articles treating this subject is appended for the benefit of those who wish to go more deeply into the subject.

Dilogarithms and Associated Functions. By L. LEWIN. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 65s.

THE subject of this book is the dilogarithm, or

$$\int_0^z (1/z) \log (1-z)\, dz$$

and its associated functions, the inverse tangent integral, the trilogarithm and other higher order functions. The author, Mr. Lewin, derives the many formulæ by elementary methods, mainly change of variable, integration by parts and differentiation of a suitable function. Some of these results have been proved already by earlier writers, but the majority are new results stated for the first time. The formulæ do not seem to be of any great interest in themselves, though it is conceivable that if these integrals were to occur with great frequency in mathematical physics the book might have practical applications. The last chapter of the book is devoted to a list of the more important results and numerical tables.

Obituary

R. T. ROLFE, O.B.E.

WE regret to record the death of Mr. Robert Thatcher Rolfe, which occurred suddenly at his home at Goldington Road, Bedford, on December 9. Mr. Rolfe, who was seventy-four, had spent over forty years on the staff of W. H. Allen, Sons and Co., Ltd., and until his retirement four years ago was chief metallurgist. Since his retirement, Mr. Rolfe had served the firm as a consultant and, in fact, had visited the Queen's Engineering Works only a few hours before his death.

Mr. Rolfe was educated at the Richmond County School and at King's College, London. He spent five years in London with Riley and Harbord, metallurgical chemists and, subsequently, a year or so with the Anglo-Newfoundland Development Company at Buchan's River. He joined W. H. Allen, Sons and Co., Ltd., in 1912. During his career, Mr. Rolfe made many valuable contributions to metallurgical literature. He was the author of a book entitled *Steels for the User* and presented a number of papers to professional institutions. Mr. Rolfe was a fellow of the Royal Institute of Chemistry, a Fellow of the Institution of Metallurgists, a member of the Iron and Steel Institute and a member of the Institute of Metals. He was awarded the O.B.E. in 1952.

For us, Mr. Rolfe's death is a personal loss. For many years he had served THE ENGINEER as a reviewer of books on metallurgical subjects and for some months past he had regularly provided our " Metallurgical Topics."

Books Received

Mathematical Tables. Volume II. By L. Fox. H. M. Stationery Office, Price 10s. 6d.

Voice Across the Sea. By A. C. Clarke. Frederick Muller, Ltd., Ludgate House, 110, Fleet Street, London, E.C.4. Price 18s.

Concrete Practice. Volume I. By R. H. Elvery. Contractors Record, Ltd., Lennox House, Norfolk Street, London, W.C.2. Price 28s.

Joints and Cracks in Concrete. By P. L. Critchell. Contractors Record, Ltd., Lennox House, Norfolk Street, London, W.C.2. Price 40s.

Hydraulic Turbines, their Design and Equipment. By M. Nechleba. Constable and Co., Ltd., 10, Orange Street, London, W.C.2. Price 45s.

Northern Region Engineering Buyers' Guide, 1958-59. The North-East Engineering Bureau, 18, Ridley Place, Newcastle upon Tyne, 1. Price 2s. 6d.

Sheet Metal Work, Part 2, Calculations and Science. By R. G. Blackburn and J. Cassidy. Edward Arnold (Publishers), Ltd., 41, Maddox Street, London, W.1. Price 10s. 6d.

Principles of Electronics. Second Edition. By H. Buckingham and E. M. Price. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 17s. 6d.

The Running and Maintenance of the Marine Diesel Engine. Sixth Edition. By J. Lamb. Charles Griffin and Co., Ltd., 42, Drury Lane, London, W.C.2. Price 58s.

Industrial Electronics Handbook. By W. D. Cockrell. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 174s. 6d.

Steam Turbine Performance and Economics. By R. L. Bartlett. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 97s.

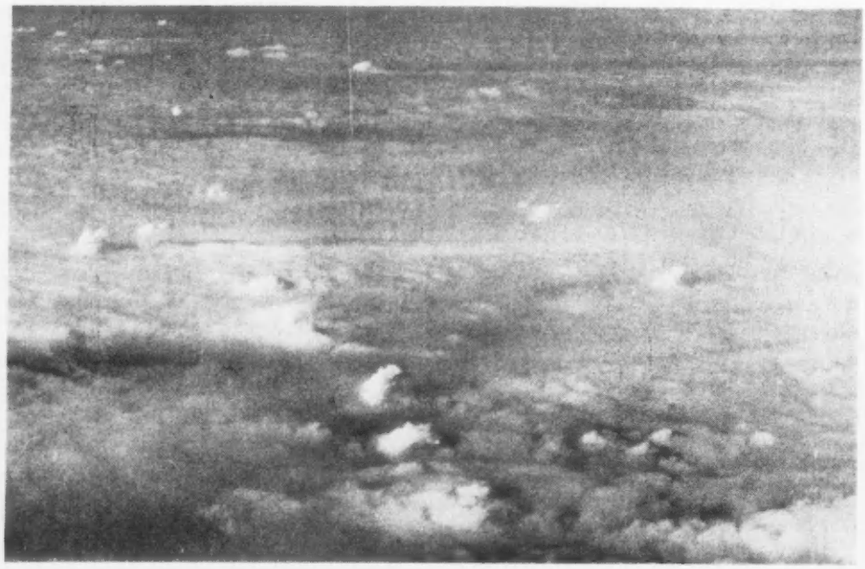
Highway Spiral, Superelevation and Vertical Curves. Third Edition. By H. Criswell. The Carriers Publishing Company, Ltd., 66, Victoria Street, London, S.W.1. Price 63s.

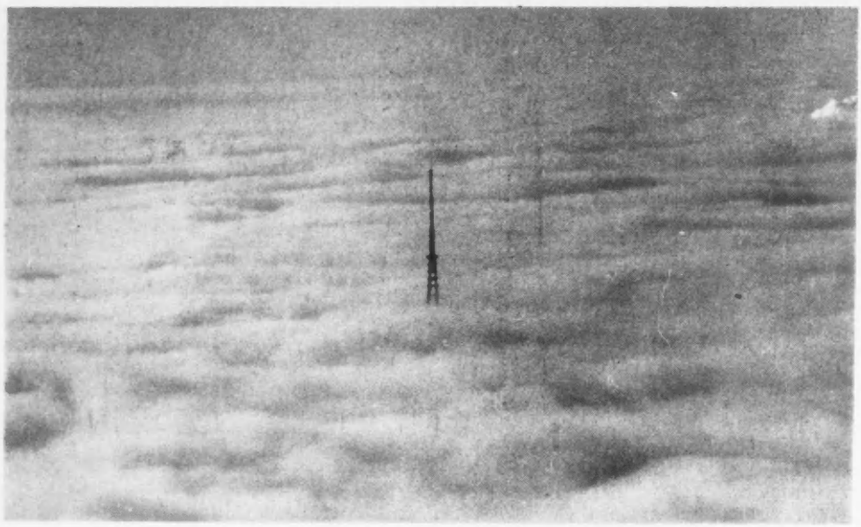
Steam Turbine Theory and Practice. Seventh Edition. By W. J. Kearton. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 57s. 6d.

Chimney Plumes

An investigation has been carried out by Fairey Air Surveys, Ltd., on behalf of the Central Electricity Generating Board, to discover whether the stack gases of power stations would rise through a layer of fog held in place by an inversion. To carry out the survey a Douglas D.C.3 was fitted with Decca Navigator equipment and a very large-scale Flight Log on which the individual chimneys of a power station could be distinguished, and also a transmitter-receiver working on the C.E.G.B. communications frequency. Since the aircraft was normally based at White Waltham, a grass airfield, arrangements were made to secure advance warning of persistent fog and move the machine to London Airport beforehand.

On December 3 a warning of persistent fog was received and the operation was brought to a full state of readiness. The aircraft was moved to London Airport and the power stations alerted. The aircraft was airborne at 08.45 hours on December 4, the take-off being made with about fifty yards forward visibility. The aircraft came out of the top of the fog into clear sunlight and proceeded to position itself over the group of power stations concerned using Decca. A number of plumes were seen penetrating the fog layer, and these were soon identified as belonging to various power stations : the UPPER photograph shows the view looking upstream from Gravesend.





The positive buoyancy of the plumes was proved by the turbulence the aircraft encountered when passing immediately above, but not in, a plume. After the initial identifications, experiments were made by colouring the gases. From Brunswick Wharf, a modern station with two tall chimneys, the efflux gases from one stack were coloured black and from the other stack red. The two plumes are seen emerging side by side from the top of the fog in the LOWER photograph.

Except when operating at higher altitudes, the aircraft had to remain within a circle of 3 nautical miles radius centred on Blackwall Point. The aircraft was kept within this circle using Decca, and particular attention was given to the power stations at West Ham, Blackwall Point and Brunswick Wharf. Notes were made of the characteristics of the plumes from visual observation. Records were made of the air temperatures throughout the climb from take-off and at various heights above the target area.

On completion of the operation over the power stations the aircraft made a dummy approach to London Airport to check temperature, and fog intensity. The approach was made with full G.C.A. on runway 28L, the aircraft overshooting at 200ft : over London Airport the forward visibility was nil, and nothing was seen of the high intensity approach lights. Over London Airport the fog top of 500ft was somewhat lower than 750ft–850ft found over London : the CENTRE photograph shows the tower of the Crystal Palace projecting into clear air to an altitude of 1068ft.

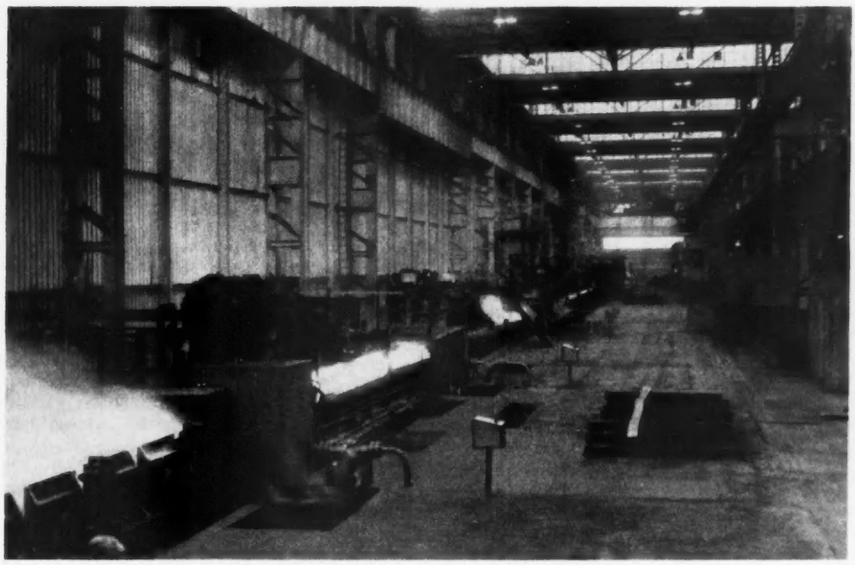
Measurements of gas temperatures, ambient air temperatures, &c., were made at the power stations during the operation. It is possible now to confirm that chimney plumes do penetrate the fog layer and discharge into the upper atmosphere. An interesting and important exception was at Bankside power station : the gas washing plant at this site reduces the flue gas temperature markedly, and the smoke failed to break through the inversion.

The Brinsworth Hot Strip Mill

For the production of steel strip up to 18in wide, the Steel, Peech and Tozer branch of the United Steel Companies, Ltd., has built a fully mechanised continuous mill at its works near Rotherham. The cost of the project is over £4,000,000. The mill has been designed for an ultimate capacity of 8000 tons a week.

THE Brinsworth hot strip mill, recently built for Steel, Peech and Tozer (branch of the United Steel Companies, Ltd.), has now completed its "running-in" period. Hot rolled strip has, of course, been a Steel, Peech and Tozer product for many years.

The Brinsworth mill building has an overall length of 800ft and is approximately 300ft wide. Its front elevation consists of rustic brickwork alternating with deep panels of glazing. The back and sides of the building are metal-sheeted, the roof being formed of



The mill bay, showing the mill stands on left and control pulpits on right

Q decking and incorporating adequate ventilation. The mill is divided longitudinally into four bays. Nearest the front elevation is the motor room, an extension of which forms the roll preparation bay. Then comes the main mill bay, followed by the slab storage and conditioning bay and the coil storage and dispatch bay.

The company's Templeborough mill, between Sheffield and Rotherham, was laid down in 1920–21, but the maximum strip width it can roll is 9in and site limitations have made it difficult to carry out any extensive enlargement. It was, therefore, decided three years or so ago that any increase in hot strip capacity would have to be achieved by building a completely new mill.

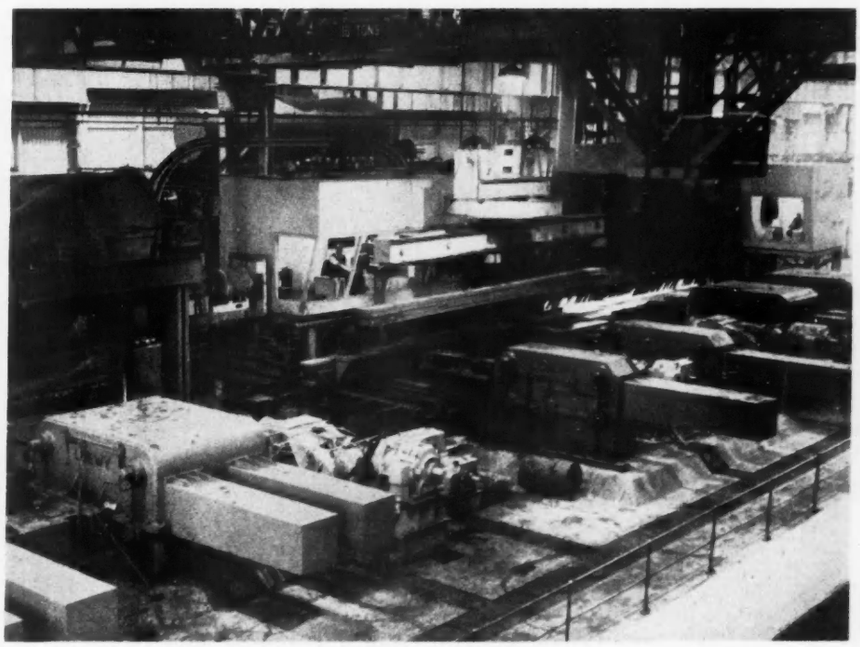
The company already owned a large tract of land opposite to its Templeborough works, and part of this site is now occupied by the Brinsworth mill. It is a highly mechanised continuous mill, capable of rolling mild, carbon and special steels up to 18in wide, the intention being to bridge the gap between the outputs of the narrow and wide strip mills now operating in this country. The mill has been designed for a capacity of the order of 8000 tons a week; at present, owing to the decline in the demand for steel, its output is below that figure. Inevitably, in the early stages of planning the new mill a number of decisions had to be taken concerning the provision of adequate steel supplies to maintain it at a high level of production. The first consideration was that of steel melting capacity. When a new melting shop was built, some years ago, at another United Steel branch—Appleby-Frodingham Steel Company, Scunthorpe—allowance was made for increasing the number of open-hearth furnaces. The Brinsworth mill gave impetus to this development and a new 300 to 350-ton open-hearth furnace was commissioned two years ago. Ingots from this furnace are delivered by railway to the Steel, Peech and Tozer works at Rotherham, and, ultimately, an average of almost 10,000 tons of steel a month will be obtained from this source.

Main Mill Bay

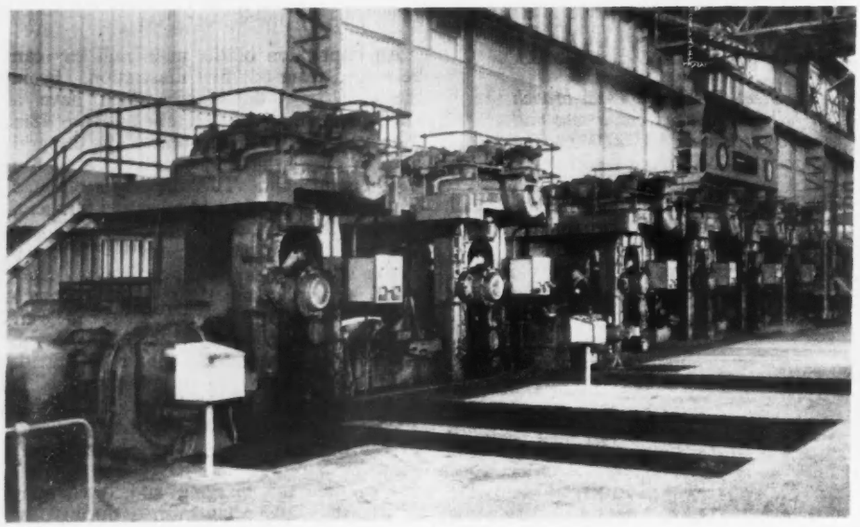
An impression of the main mill bay can be gained from our first illustration. From the slab bay, the slabs, which have a maximum length of 28ft 6in and are 18in wide and 3in thick, are placed on the grid of a depiler which incorporates a 30-ton weighing machine. This depiler is situated centrally between the two reheating furnaces, the slabs being fed singly on to either of two furnace charging roller tables.

The reheating furnaces, which are illustrated herewith, are oil fired and are each capable of heating 75 tons of slabs per hour. Both are equipped with Schack recuperators, in which the air for combustion is preheated, waste gas flues and cold air ducts enabling the recuperators to be by-passed for repairs. There is a 22,000 cubic feet per minute cold air fan and a 70,000 cubic feet per minute waste gas fan for each furnace. The furnaces are of the end charging and discharging design, the slabs being pushed through the heating zones by electrically operated twin pushers. There are two heating zones, known as tonnage and soaking respectively the second zone being divided into three control zones across the width of the furnace.

Both furnaces are equipped with a comprehensive system of instrumentation and automatic control. The control covers temperature, atmosphere and pressure in the various heating zones; many of the important variables are recorded on a multi-channel recorder. If a slab has to be diverted from the mill on emerging from the furnaces to a discharge table, it is conveyed to a section of the table between the two furnaces. There, the slab can be positioned and then conveyed by means of a slab transfer to a roller table and so back into the slab bay. A live roller table, 135ft long and extending across this discharge end of the two furnaces, takes slabs to the first section of the mill, consisting of a horizontal edging and scale-breaking stand, driven by a 350 h.p. a.c. motor through a flywheel-assisted reduction gear. The horizontal edger is equipped with manipulators on the ingoing side to turn the slabs on edge, while further manipulators on the outgoing side turn the slabs back ready for entry into the first roughing stand.



The two reheating furnaces, showing slab depiler and furnace pushers. Each furnace is capable of heating 75 tons of slabs per hour



The finishing train has six four-high rolling mill stands and two vertical edgers

The roughing train comprises four two-high mills having 21in diameter rolls of 24in barrel length. Preceding No. 3 rougher, there is a 26in vertical edging stand. Between stands Nos. 1 and 2 there is a free run of 38ft with a 63ft run between stands Nos. 2 and 3. Stands Nos. 3 and 4 are close-coupled. A centralised oil lubrication system supplies the main gearbox and pinion stands of the roughing train, a visible and audible alarm system operating automatically if the oil pressure falls below a predetermined limit. All the stands in this train are equipped with totally-enclosed, water lubricated fabric bearings. No. 1 stand of the roughing mill is driven by a 700 h.p. a.c. motor through a flywheel-assisted reduction gear unit, Nos. 2 and 3 stands by 1200 h.p. a.c. synchronous motors, and No. 4 stand by a 1200 h.p. d.c. motor.

From the roughing mill, the stock travels along a 150ft long delay table before passing a rotary flying shear, which can be used for either end trimming or emergency shearing in the event of "cobbles" in the finishing train. The shear, which is powered by a 300 h.p. d.c. motor, can cut hot strip up to 1in thick and 18in wide, travelling at a speed of up to 450ft per minute. The finishing train of the strip mill has six four-high rolling mill stands and two vertical edgers. Both edgers are driven by 75 h.p. motors, the first being situated in front of No. 1 finishing stand, and the second between Nos. 2 and 3 finishing stands. Each of the six finishing stands has 14in diameter work rolls and 23in diameter back-up rolls, all being of 23in barrel length. The mill stands are equipped with electric screwdown gear, the work rolls being mounted on tapered roller bearings, and the back-up rolls on multi-roller cylindrical bearings. Lubrication of the bearings is carried out by an automatic pumping system. A centralised oil lubrication system, similar to that installed on the roughing mill, supplies the main gearbox and pinion stands. Stand No. 1 is driven by a 1200 h.p. d.c. motor, Nos. 2, 3, 4 and 5 by 1750 h.p. d.c. motors, and No. 6 by a 1200 h.p. d.c. motor. By the time the strip reaches the last finishing stand, it is travelling at up to 3000ft per minute and proceeds along a 160ft cooling table, where a bank of water sprays can be used if cooling is required. Next, the strip is coiled on either of two 20in diameter horizontal down-coilers, illustrated herewith, each operated by 175 h.p. d.c. motors. Completed coils are ejected from the coiler drum and placed on a conveyor for onward transmission to the coil storage and despatch bay.

During the actual rolling process, continuous measurements of the temperature, width and thickness of the strip are taken. The temperature is measured at four points and recorded on large circular indicators which are clearly visible to the mill operatives. Strip width is measured between the last finishing stand and the coilers by means of a photo-electric telescope system mounted above the cooling table, deviation of the actual width from the desired width being indicated in a similar manner to the temperature readings. Thickness measurement is also obtained by a non-contact method employing a radioactive source positioned beneath the strip and a detector unit above the strip. The intensity of radiation reaching the detector varies with strip thickness, the variations—after passing through electronic equipment—being displayed pictorially on a lamp display board on the motor room wall. A permanent record is transmitted to a teleprinter in the finishing mill pulpit.

Coil Bay

The 600ft long coil conveyor runs underneath the slab bay and emerges down the middle of the coil bay, from where the coils can be lifted by magnet crane and placed in storage while cooling. The conveyor operates at a speed of 30ft per minute and can handle coils weighing up to 5600 lb ; it incorporates a 3-ton weighing machine, fitted with chart and card punch recording equipment. There are two shearing lines, each comprising a decoiler, an edge trimming shear, a roller flattener combined with a flying shear, a piling device and a 10-ton weighing machine. They are capable of shearing strip up to 18in wide and 0·08in to 0·25in thick in maximum lengths of 30ft.

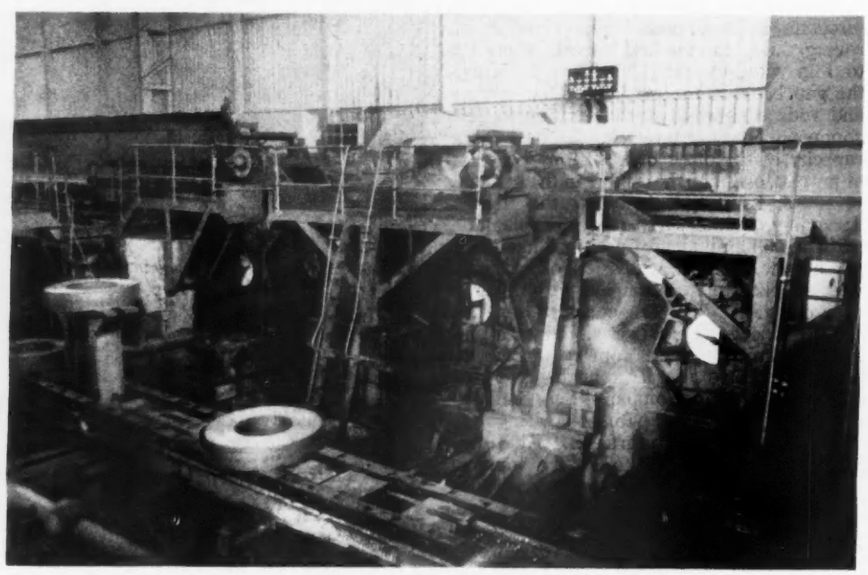
A separate inspection line is installed at one end of the bay, where strip up to 19in wide and from 0·042in to 0·25in thick can be gauged and inspected. The line includes a hydraulic shear for removing faulty material and can produce small coils of strip, if required. A railway dock extends the full length of the bay, adjacent to the slab bay, and road transport can obtain access at both ends of the bay for the despatch of finished products. Three 10-ton overhead cranes serve the coil bay.

Pickling Plant

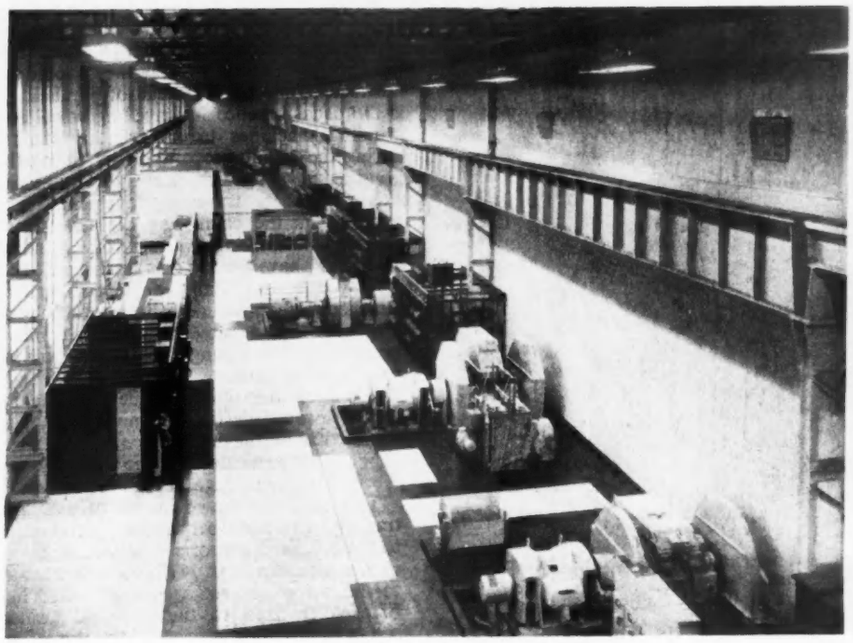
As a proportion of the hot rolled strip is pickled before despatch, a separate building, 550ft long by 66ft wide, has been erected alongside the main building to accommodate two multi-strand pickling lines with appropriate ancillary equipment. The strip is uncoiled and fed between staggered steel rolls which bend it sufficiently to break up the hard, loosely adhering scale. The strip then passes through a tank of dilute sulphuric acid to remove the remainder of the scale, the acid being removed in hot and cold water tanks. Finally, the strip receives a coating of soluble oil before recoiling.

Communications

The Brinsworth mill is well equipped for the rapid dissemination of information during all stages of the rolling process. The inter-communication system includes microphones and loudspeakers at strategic points throughout the building ; the main mill system has twenty-eight key points.



The strip is coiled on either of two 20in diameter horizontal down-coilers, each having a collapsing mandrel and nine driven guide rollers



The motor room from the roughing stands end

For the centralised registration of the production performance of up to twenty machines in the mill, a "Centralograph" recorder has been installed. During normal production, detecting contacts on the machines transmit electrical impulses to the "Centralograph," which are recorded as short horizontal lines on a time-referenced diagram called a "centralogram." This diagram is divided into twenty columns to represent the machines and shows at a glance the machine time (horizontal lines) and the idle time (blank spaces). The reasons for stoppages are reported manually on a dial located near each machine and are recorded on the "centralogram" in the form of a numeral at the side of the line registration. Each numeral corresponds to a certain reason for stoppage, according to a predetermined code.

Electrical Equipment

The main electrical equipment for the mill is accommodated in a separate pressurised motor room, part of which is shown in our final illustration. The same bay contains the roll grinding shop and a maintenance shop. The total electrical power requirement is put at 23,000 h.p.

The mill is rectifier fed, the electrical feed to the main drive d.c. motors being converted from a.c. by a bank of rectifiers. The main drives, rectifiers and control gear are housed in the main motor room, with the auxiliaries on the mill floor and in the basement. The total installed rectifier plant is 9000kW ; it comprises twenty-four English Electric steel tank mercury-arc rectifiers group according to the size and duties of the various drives. To give full access for maintenance of the equipment, the rectifier tanks are trolley mounted. They are installed behind shallow cubicles which house all the associated auxiliary equipment, the cubicles forming a rectifier enclosure within the motor room. A thermostatically-controlled ventilation system is installed in this enclosure.

Master and supervisory control of the main drives for both roughing and finishing is carried out from open boards with all components mounted on polished slate panels. The control of the main drives and of a large percentage of the auxiliaries is carried out from pulpits designed for seated operators overlooking the mill.

Principal Contractors

Air Control Installations, Ltd., ventilating fans ; W. Boby and Co., Ltd., water treatment plant ; Brightside Heating and Engineering Company, Ltd., service pipework ; British Insulated Callender's Cables, Ltd., electric cabling ; The English Electric Company, Ltd. and Metropolitan-Vickers Electrical Company, Ltd., electrical equipment ; Loewy Engineering Company, Ltd., continuous strip mill ; Stein and Atkinson, Ltd., reheating furnaces ; Solano Air and Heat Systems, Ltd., control pulpits. Mr. Donovan H. Lee, M.I.C.E., M.I.Mech.E., was the consulting engineer.

Roll Grinding Machine

A heavy-duty roll grinding machine of travelling wheelhead construction and having a capacity for grinding rolls up to 42in diameter, 16ft long, has been supplied to the Steel Company of Wales, Ltd., by the Churchill Machine Tool Company, Ltd. These machines are built in three sizes for 32in, 42in and 66in diameter, and are designed for a rapid rate of metal removal to a high degree of finish. They incorporate an improved mechanism for cambering or crowning rolls.

A NEW range of heavy-duty travelling wheelhead roll grinding machines now being made by the Churchill Machine Tool Company, Ltd., Broadheath, Manchester, is available in three sizes, having capacities for rolls of 32in, 42in and 66in diameter. The first of these machines which has been supplied to the Steel Company of Wales, Ltd., is of the intermediate 42in diameter grinding capacity and takes rolls up to 192in long between its centres. This machine can be seen in the accompanying illustrations and it is stated that in the course of its tests at the maker's works it satisfactorily ground 0·024in from a 20½in diameter hardened forged steel roll 80in long in fifteen minutes.

The bed of the machine is made in two longitudinal sections, rigidly bolted together along their length. One section carries the workhead, tailstock and roll steadies, whilst the other incorporates large ways on which the wheelhead carriage slides. Both of the bed sections are very heavily built with double ribs to support the shears and with very substantial cross ribbing to give the necessary stiffness and stability whilst the machine is grinding at its maximum power and cutting rates. The rigidity of this construction was shown in tests when roll finish was found to be 1½ to 2 micro inches when measured by a "Taly-Surf" instrument.

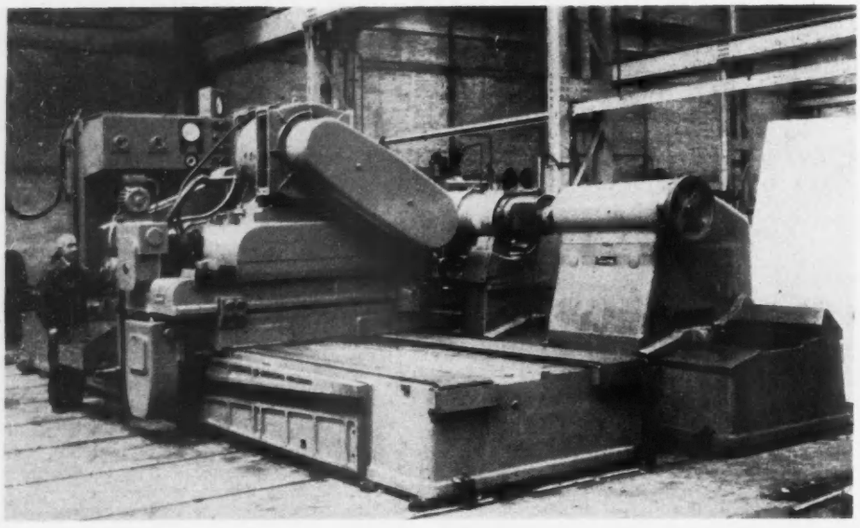
The slideways on the wheelhead bed section are automatically and continuously lubricated with filtered oil and pressure switches in the oil feed lines ensure that the wheelhead carriage traverse cannot be started until the oil is circulating.

The traversing wheelhead carriage is driven by a Ward Leonard controlled, variable speed 5 h.p. reversing motor through a gearbox at from 3in to 110in per minute. Traverse control dogs, on a drum situated on the front of the gearbox and driven from one of its motion shafts, are adjustable for setting the length of the wheelhead carriage traverse. These dogs operate a heavy-duty reversing switch in the gearbox cover. The carriage can be started, stopped or inched by push buttons on the control desk and it can be reversed by hand at any point in the traverse by movement of a ball-handled lever attached to the reversing switch mechanism. An adjustable electronically controlled dwell is incorporated by means of which reversal of the carriage can be delayed at the end of the traverse stroke to ensure that the whole of the roll periphery is ground at the extreme ends of the face.

All the mechanical and electrical controls for the grinding operation are adjacent to the platform, from which the operator thus has complete control of the machine without leaving the working position. Hand-wheel-operated speed regulators are used for adjustment of the carriage traverse speed and the wheel spindle speed, each of these regulators carries a pointer and calibrated indicator plate. The carriage traverse regulator is calibrated in inches per minute for each gear ratio and the wheel spindle regulator in revolutions per minute. A large diameter tacho-indicator on the desk shows the speed of the roll in revolutions per minute and work speed can be adjusted by means of fast and slow push buttons.

The control desk also carries push buttons for the wheelhead main motor and an ammeter with a scale calibrated in horse-power on the top of the desk enables the power being absorbed by the grinding wheel to be observed both from the carriage and from the shop floor.

In the wheelhead a 40 h.p. variable speed motor drives the "Nitralloy" steel wheel spindle through multi-vee belts at speeds from 345 to 690 r.p.m. The large diameter wheel spindle cone adjustable bearings are of leaded bronze and are lubricated by an independent pump motor from an oil reservoir within the wheelhead. An oil cooler is used to assist in



Travelling wheelhead roll grinding machine with automatic electronic wheel feed mechanism and roll cambering equipment

maintaining the wheelhead at constant temperature when running and a thermostat is fitted to protect the unit against excessive rise in temperature. Pressure switches in the oil feed lines ensure that the spindle cannot be rotated until oil pressure is available and also that it will be stopped automatically should the pressure fail. A standard grinding wheel, 36in diameter by 4in wide, is used on the machine.

Hand feed to the grinding wheel is applied by rotating a large hand-wheel and this hand-wheel is graduated in divisions equal to 0·000125in feed or 0·00025in reduction in diameter.

In addition to the grinding wheel hand feed, the maker's automatic electronic feed mechanism has been incorporated to ensure that the maximum use can be made of the power available at the grinding wheel. With this device in operation, the grinding wheel is first fed forward by hand until the wheel load has been picked up and the wheel is then traversed along the length of the roll face. The mechanical load on the grinding wheel motor then falls because of the material removed in first traverse and a corresponding reduction in motor armature current then takes place. This current is directly proportional to the horsepower output of the motor and the automatic feed mechanism is designed to ensure that a feed is applied immediately a fall in current takes place. It ensures that the cut taken by the grinding wheel is kept constant at a selected amount during either a roughing or finishing operation.

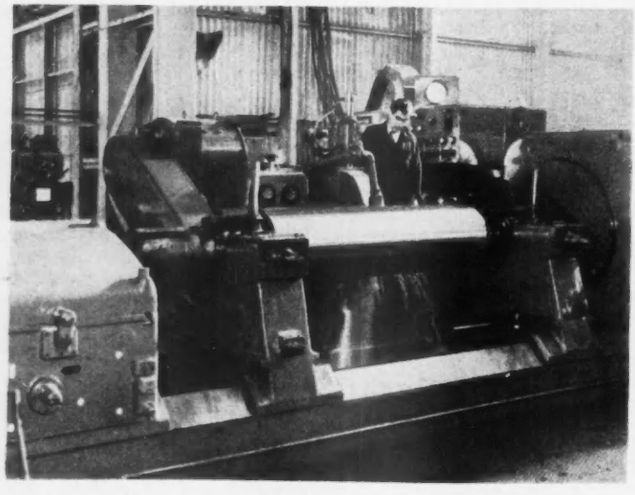
The operator can set the regulator of the device to any value of load current within the capacity of the grinding wheel motor and it is not necessary for him to observe the fall of current on the grinding wheel, as the feed is automatically applied immediately the current drops below the set figure. This figure of load on the motor can easily be regulated at any time by means of a control knob, and it can be set to any value between that required to drive the grinding wheel spindle without any cut and the maximum grinding load. For finish grinding, the feed regulator can be adjusted to a low value, and as the finish is built up it can be reduced in stages down to the lowest possible setting. The process of finishing then becomes almost automatic and amounts of feed smaller than are possible by hand can be obtained automatically. A further useful feature of the device for finish grinding is that after wheel retruing the feed can be engaged at its minimum setting to drive the wheel forward until it just touches the face of the roll without the danger of the wheel " digging-in."

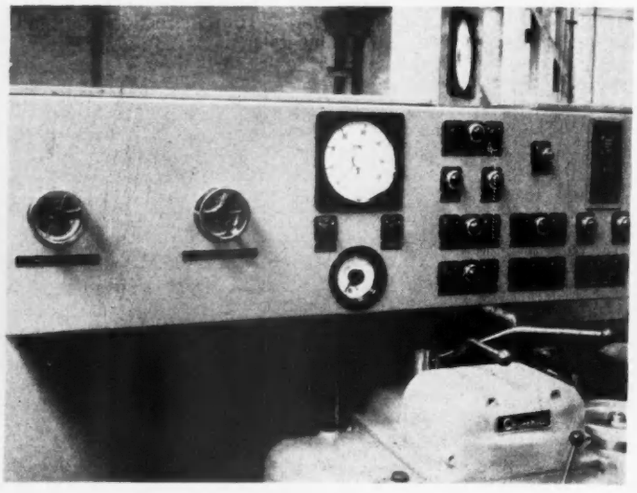
To offset the effect of the deflections on work rolls when subjected to high pressure in the mill, it is necessary that they should be crowned or cambered instead of parallel. It is the usual practice in travelling wheel roll grinding machines to impart this camber during the grinding operation by tilting the grinding wheel towards or away from the roll axis during its traverse movement. For many years the cambering devices on the Churchill travelling wheel roll grinding machines have used this principle and employed an adjustable angle camber bar attached to the machine bed, from which has been obtained the movement for the cambering mechanism during the traverse of the wheelhead carriage.

The cambering device on the new machine is of improved design, retaining the angled camber bar but having a much wider field of application, particularly in the production of special camber forms and high lift crowns.

This device is shown in one of our illustrations. In it a camber bar fixed permanently to the bed has a slot or slideway *A* machined in it at a fixed angle. A slipper *B* is attached to the end of lever *C* which is pivoted in a bracket *D* fixed to the carriage. Linear movement of this slipper in the slot of the camber bar as the wheelhead carriage traverses along the bed gives an angular motion to the lever *C* and to disc *E* which is fastened to it. A cam secured to the top platform of this disc gives rise or fall movement during angular displacement to the free end of lever *F*, whose fulcrum is at *G* on the bracket fixed to the carriage. This movement is transferred to a further lever *H* pivoted at *J* on this same bracket. The amount of movement finally given to this lever is varied by adjustment of a connecting piece between the levers *F* and *H*, the setting being made by the knurled knob *K* against a graduated scale shown at *L*. A ball located in a ring on the upper face of lever *H* transfers the movement to the end of the wheelhead slide, which is supported at its front on trunnions. A capstan located underneath the wheelhead slide at the rear end is used to take the weight of the wheelhead off the cambering mechanism during the setting or adjusting for camber or to support the base when grinding parallel rolls. Special cams can be introduced to obtain special forms or high crowns on rolls.

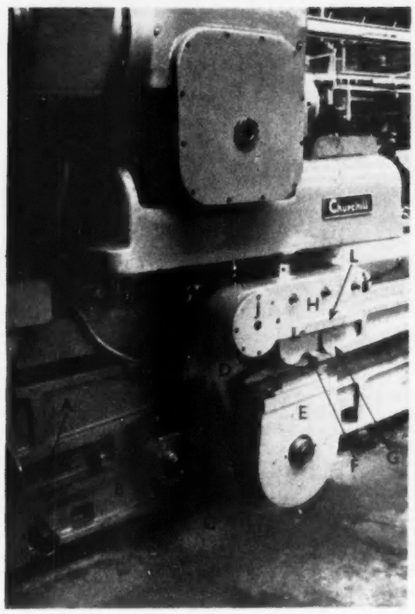
In the workhead the whole of the reduction drive is by a system of multi-vee belts from a 20 h.p. d.c. variable speed motor to give final work speeds of 15 to 60 r.p.m. The





(Left)—Rear view of machine engaged in grinding a roll. The compact main control panel can be seen on the left of the operator. (Right) Main control panel adjacent to the operator's platform. The speed regulator handwheels are on the left, the work speed indicator dial in the centre, and the main push button controls on the right

workhead is of dead centre design with a heavy forged steel spindle of large diameter. The final pulley of the drive to which is attached the compensating driving plate is 46½in in diameter and its bearings comprise a pair of widely spaced preloaded taper roller races of 18¾in bore diameter. The tailstock of the machine, which is mounted and guided along the same bed slideways as the workhead, is in two portions, the top piece having set-over adjustment for alignment purposes. Both workhead and tailstock are adjustable along the bed by power, and the motor and worm gear reduction units for this purpose are built into the heads. Both heads have heavy pawls fitted at their rear ends to engage with a rack in the body, so as to assist the



Profiling equipment for use when grinding crowned or cambered rolls

clamp bolts in resisting the thrust of the rolls.

Whilst parallel journals can be ground on the machine with the roll mounted on centres, the grinding of taper necks, however, presents a special problem and this has been met by providing an auxiliary wheelhead. This wheelhead is carried on a separate carriage on the wheelhead bed, which is extended at the tailstock end to provide accommodation for the head when it is not in use. The auxiliary wheelhead carriage is stationary on the bed when grinding taper necks and when in the grinding position it traverses along a swivel slide set to the angle of the taper journal.

The control panel on the carriage, which has the instrument desk mounted at the back, controls all motors on the carriage. A separate floor mounting unit houses the contactors and relays for the motors on the remainder of the machine, together with the necessary electrical protection and isolating switches for the a.c. and d.c. incoming supplies to the machine. For reasons of safety and reliability, all the a.c. and d.c. control circuits are operated from a low voltage source provided in the control equipment.

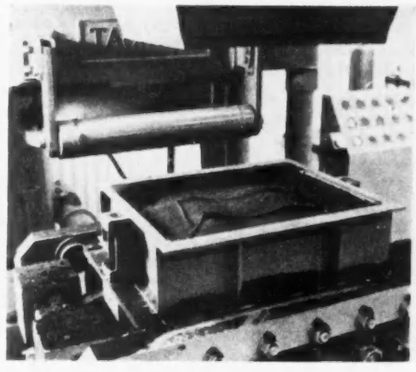
POWER STATIONS IN IRAN.—Two power stations recently constructed on an Electricity Transmission Line route from Abadan have been equipped with generating sets supplied by Mirrlees, Bickerton and Day, Ltd. At Bandar Mashur are three mark KVSS.12 engines, each coupled to a 2020kW alternator, while at Agha Jari are two KSS.6 engines, each driving a 1012kW alternator.

High Production Automatic Moulding Machine

WHEN a new demonstration bay for foundry machinery was opened recently at the Bedewell Works, Hebburn-on-Tyne, of Baker Perkins, Ltd., there was shown in operation a " Taccone " diaphragm moulding machine which the company is now handling in this country. This design of high production moulding machine, which was developed in the United States and is widely used in that country and on the Continent, has not hitherto been seen in this country. In the process used a box placed over a pattern is filled with moulding sand which is then compressed on the pattern by the admission of compressed air behind a flexible diaphragm above the box. The pressure imparted by the diaphragm over the whole of the sand surface gives it an evenly distributed pressure over the pattern regardless of the variations in contour, and in the resultant mould the degree of hardness is uniform throughout. The machines are designed for use with green sand having a moisture content below 6 per cent and many different kinds of sands have been used successfully with them. They are arranged for either semi- or fully-automatic sequence operation, and a push button control panel is fitted on a cabinet which can be situated in any convenient position. The machines are shockless in operation and can be installed on any normal foundry floor without need for reinforcement or heavy foundations.

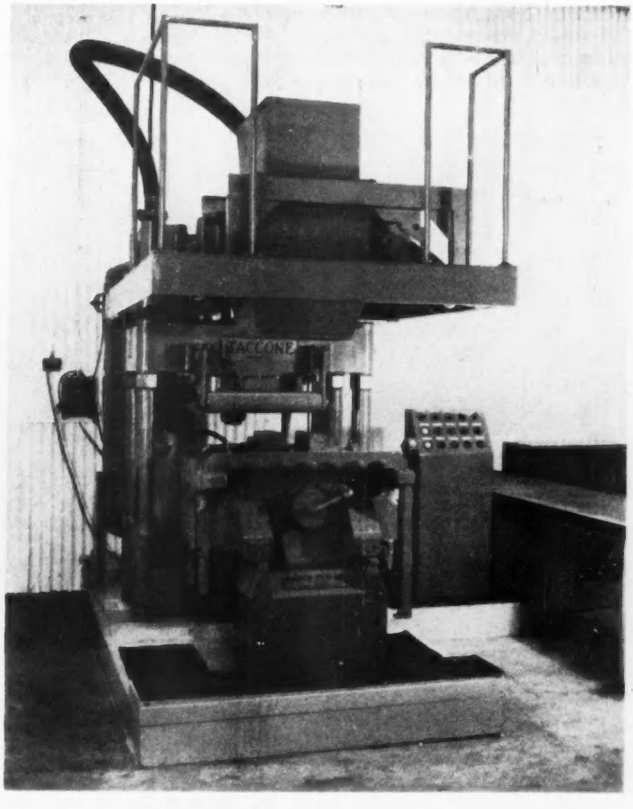
The construction of the machine demonstrated can be seen in our illustrations; although a number of different sizes and capacities are made, the general operating principles are the same. Mould boxes are fed into the machine from a roller conveyor at the side, and they pass in turn on to a pair of spaced bearer rails, or stripper bars. This bearer rail assembly is supported on four elevating rams from the main carriage of the machine, which runs on machined guide ways across the base. The rail assembly is lowered through its rams to deposit the box over the pattern fixed on the table of the carriage. The correct positioning of the box is ensured by guide dowels which register in the location holes used when closing and locking moulds.

A measured quantity of moulding sand is then deposited in the box from a sand hopper mounted on a platform above the table. As the carriage is drawn back into the machine by a large air cylinder the heaped sand above the sides of the box is levelled off and slightly compressed as it travels below a freely rotating roller on the head. At the end of its retraction stroke into the body of the machine the weight of the carriage is transferred from its rollers to pads which register on the slideways of the base. The box is then directly below a large air cylinder retracted into the lower end of which



Mould box extracted from diaphragm head after compaction of the sand on the pattern

is a bucket-shaped, flexible rubber diaphragm. Upon a volume of compressed air then being admitted to the cylinder the diaphragm is instantaneously blown outwards and downwards into contact with the sand in the mould box. The heavy evenly distributed pressure imparted to the sand by the diaphragm compresses it tightly over all the contours of the pattern, and against the box sides, as



Diaphragm moulding machine for high production automatic operation

shown in one of the illustrations. The resultant mould is completely self-supporting in the box.

This mould "squeezing" operation takes one to two seconds and on a slight vacuum being introduced in the cylinder the diaphragm is withdrawn into the chamber. The carriage ram then operates to push it out to its original position at the front of the machine. The bearer rail elevating cylinders are operated to raise the mould box clear of the pattern. As the mould is removed from one side of the machine an empty box is pushed in from the opposite side ready for the next moulding cycle. When the machine operates on an automatic moulding cycle, switches, which are actuated at the end of each movement, operate valves for starting the next movement in the sequence.

These machines can be used for production with any general wooden or metal pattern, but owing to the very high speed at which the sand is compressed provision for air venting has to be made in the pattern or the platen on which it is mounted. The production rate of the machines is very high, even with individual movement control by push button operation, and no skill is required for their operation. The rubber diaphragms are stated to have an average life for producing over 60,000 moulds, and if accidentally split they can be repaired by adhesive or vulcanising processes.

The machines are made in ten standard models to take boxes from 12in by 18in, with a 4in draw, to 35in by 96in with a 10in draw. Irrespective of the size of mould made the actual squeeze period is only between one and two seconds.

In our illustration of the demonstration bay, which has a floor area of some 4000 square feet, the "Taccone" machine can be seen on the left, whilst on the right are representative models of the shot blasting machines made under licence by the firm. They include a rotating drum, a rotating barrel and rotary table machines. In these machines the shot is projected by an impeller driven by an electric motor, the power of which can vary from 5 h.p. to 20 h.p.

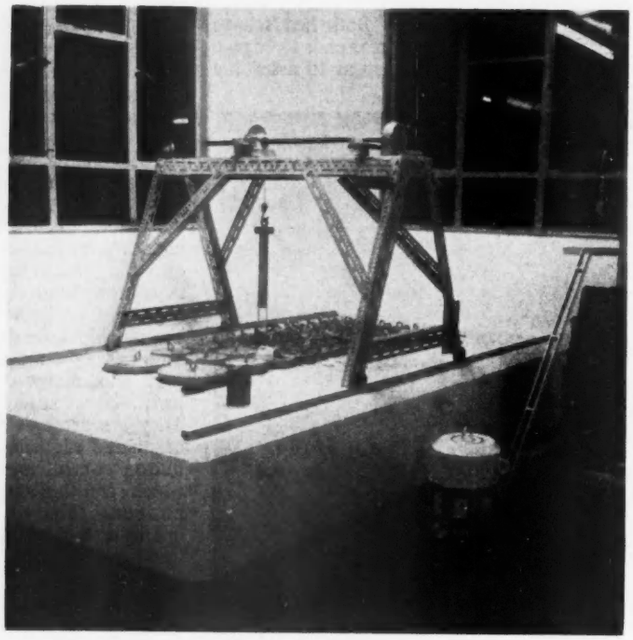
Foundry machinery demonstration bay with "Taccone" moulding machine on the left and shot blast machines on the right hand side

Radioactive Laboratory for Isotope Work

RADIOACTIVE isotopes are applied in technology in two principal ways : as "tracers," to label non-active atoms of the same or other elements, and as sources of radiation. The first kind of application is necessarily confined to research where stringent precautions can be taken to prevent the escape of any active material, while the second has in recent years been extended to many classes of production processes, as well as to radiography where γ- radiation from cobalt or iridium sources can often be used advantageously in place of X-rays. Production applications depend almost entirely on measuring the absorption of β- or γ-radiation by various materials. This requires a radioactive source, a suitable detector of the radiation after it has passed through the material under test, and an amplifier coupled to a recorder or controller, as the case may be. The absorption measurements can be converted to indicate thickness or density, or the rise of liquid inside a container can be made to cut off the beam and in this way indicate level.

Sources for use with such equipment vary in strength from a few tens of micro-curies to about half a curie. They must, of course, be safely mounted in holders which will ensure that the radiation can only emerge in the direction required and can be shut off completely during transit or maintenance. The shutter may be fitted with a fork to prevent unauthorised opening.

The general procedures to be adopted when dealing with radioactive material in the laboratory have become well established over the last fifteen years, but it may be of interest to describe a recent installation for the storage and assembly of radioactive sources for industrial use.



Concrete block for storing gamma sources. Aluminium capsules containing the sources are fixed to the lower end of lead plugs which can be raised and lowered by means of the gantry. The storage holes in the 2ft thick barytes concrete are covered by lead discs

The laboratory at Beenham Grange, near Reading, of Isotope Developments, Ltd., manufacturer of industrial nucleonic equipment has been designed for this purpose. The sources are normally sealed and tested for leakage by the supplier (the United Kingdom Atomic Energy Authority) and there is little risk of contamination by radioactive material from them. The laboratory is also used for tracer experiments involving small quantities of "open" sources in the form of liquids or powders. It is therefore constructed of materials which could be decontaminated easily in the event of a spill during these experiments, or in the more unlikely event of damage to a sealed source.

The floor is covered with semi-tropical asphalt which has a non-absorbent surface. The walls and ceiling are lined with plaster board to give a ledge-free surface which is painted with a special chlorinated rubber paint. Working surfaces are covered in smooth plastic material.

The building has three separate areas, the annexe, the source store, and the laboratory proper. The annexe acts as a "buffer" area between the parts of the laboratory where radioactive materials are handled, and the outside world, and entry to the laboratory is always made by way of it. There protective clothing is kept, and no one is allowed into the laboratory proper unless wearing standard protective clothing. Doors lead from the annexe into the store and into the laboratory. There is also a connecting door between store and laboratory.

The store contains a concrete storage block for gamma sources, a bay shielded with interlocking concrete blocks for loaded gamma source units, and a steel cabinet for the storage of beta sources, while the laboratory itself has a concrete-and-lead loading cell for gamma sources, a

"Perspex" shield for loading beta sources, and a fume cupboard. Both laboratory and annexe have stainless steel sinks with drainage into a special storage tank for contaminated liquids.

The storage block of barytes concrete (Fig. 1) has a number of 2ft deep fully shielded storage holes for the gamma sources, mainly radiographic capsules, held ready for loading into source holders. A metal insert with a lead plug at the top carries an aluminium can containing the source to the bottom of the hole.

This can is easily removed using long-handled tongs when the insert is raised by means of a gantry hoist. On removal from the insert the can is placed in a lead pot mounted on a trolley to transport it to the gamma loading cell. Once loaded into source holders the sources are stored behind a wall of interlocking concrete blocks until required for despatch.

The steel cabinet is designed to provide separate shielded compartments for beta sources. These are usually in the form of metal foils from the Radiochemical Centre, Amersham, and before being placed in the cabinet they are shielded with "Perspex," lead, or by fitting into a standard source unit. Since there may be some residual radiation from the shielded sources, a ½in thick steel door is used to close each compartment. The top, back and sides of the cabinet are lined with lead to ensure that residual radiation is reduced to a safe level.

The loading cell provides shielding and remote handling facilities to enable gamma sources to be loaded into their holders in safety, and is for the greater part built of concrete. The 4in thick lead wall across the front incorporates remote handling tongs and an 8in thick lead glass window for viewing the inside of the cell. A mirror is mounted over the top of the cell and gives a different viewpoint so that all parts of the cell are clearly visible. Holders and sources are introduced into the working area through a port with a lead-lined door across it to absorb radiation scattered from the concrete walls of the cell. A radiation alarm is installed to give warning of the presence of unshielded sources in the cell so that the door is not inadvertently opened. For loading the less penetrating beta sources, a "Perspex" shield provides protection and remote handling facilities. The loading cabinet has a central compartment where the bulk of the sources is stored while individual ones are loaded. The sources are clamped in holders and the final operations may be completed by gloved hands through the portholes in the "Perspex."

There is a fume cupboard which is used mainly for handling radium foils, and for some tracer experiments. It is fitted with an extraction fan protected by a filter.

Detailed records are kept of the nature, activity and location of all sources on the premises, and of those despatched to customers. Serial numbers and technical particulars as to the kind of isotope, the activity and the date of installation are stamped on the source holder. This information is also sent to H.M. Factory Inspectorate so that the presence of a radioactive source in a factory is known to them.

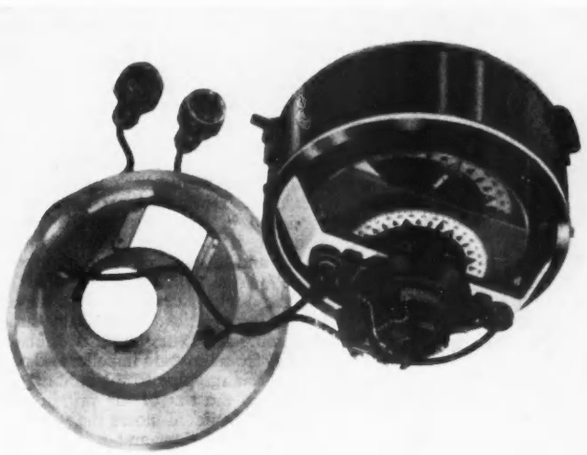
Alpha, beta and gamma sources incorporated in nucleonic gauges are constructed as sealed sources, so that even before they are loaded into their protective shields there is no risk of leakage of radioactive material.

Technical Reports

Design of Eccentrically-Loaded Columns by the Load-Factor Method. By J. D. Bennett. *Tables for the Design of Rectangular Beams and Slabs.* By J. S. Cohen. Concrete Publications, Ltd., 14, Dartmouth Street, Westminster, London, S.W.1. Price 8s. and 4s. respectively.—These brochures have been prepared to simplify the design of reinforced concrete in accordance with the load-factor method as recommended (for the first time in Great Britain) by British Standard Code No. 114, issued in 1957. Mr. Bennett's work gives twenty charts for the design of columns subjected to direct load and bending about one axis of symmetry, and reinforced symmetrically or unsymmetrically with mild steel and cold-worked bars. Mr. Cohen's tables relate to the design of rectangular beams by the load-factor method and also by the elastic method, so that it is possible to see at a glance which is the most economical for any particular beam. Worked examples are given with both sets of tables. Both brochures are reprinted from *Concrete and Constructional Engineering.*

Transmitting Magnetic Compass

RECENTLY Kelvin Hughes (Marine) Ltd., St. Clare House, Minories, London, E.C.3, announced that it had developed a transmitting magnetic compass and that the instrument had successfully completed sea trials extending over a period of nearly five years. Furthermore, it has been approved by the Admiralty Compass Observatory for use as a ship's standard navigational compass. Essentially, the equipment consists of a conventional standard magnetic compass which includes a reflector unit for stand-by purposes so that a separate magnetic steering compass is unnecessary. A detector unit is fitted externally to the underside of the bowl and notes the ship's movement about the compass card, while a servo-motor keeps the detector aligned with the magnetic system and is connected to a transmitting device which feeds information to repeaters throughout the ship. Our illustrations show the detector and servo-motor, and a steering repeater and pedestal having an 8in wide ground glass screen on which an image covering a 30 deg. sector of the compass card is projected. The sensitive but robust detector/transmitter unit will detect and transmit compass card movements of less than ½ deg. and does not affect the accuracy of the standard compass. Up to four repeaters, which can be fitted without regard to surrounding magnetic influences, can be operated from the standard transmitter and this number can be increased by the addition of a retransmission unit. Simple electrical circuits and few moving parts make for high inherent reliability and the equipment can be used to stabilise radar displays and direction finding bearing scales.



Underside of compass bowl showing the card for the projector tube, the detector and servomotor

In the Kelvin Hughes system, the principle employed is the detection magnetically of the lines of force of the compass magnet and this is done by external equipment, so that the bowl contains no electrodes or photo-electric cells, and therefore the magnetic compass is not affected. Original trials of the newly-developed equipment took place on the "Lairds Ben" and since then the "Duke of York," "Invicta," "Marengo," "Diomed," "Earnest Holt," and the company's own research vessel, "Lalla Rookh II," have been fitted with the compass.

The detector/transmitter unit consists of a detector coil and sliprings, follow-up servo-motor and a step-by-step transmitter, and the magnetic forces resulting from the unit have no measurable effect on the accuracy of the compass. There is a bulkhead-mounted amplifier having four plug-in chassis for oscillator, preamplifier, reference phase power amplifier and control phase power amplifier. Also supplied is a bulkhead-mounted distribution box and the power supply required is 110V d.c., there being a rotary transformer to provide 24V d.c. for the transmitting circuits.

A 200 c/s signal from the amplifier energises the detector coil and its secondary winding gives zero output when the coil is in line with the North-South points of the compass magnet. This is the null position, and movement away of the magnet sets up change in the direction of the magnet flux to generate a signal, in the secondary winding, which is amplified and fed to the follow-up motor. The phase of the signal determines the direction of rotation of the motor, while the voltage amplitude governs the speed, and the angle between coil and magnet controls the voltage so that at null point the motor stops. The coil is coupled by a 90 : 1 gear to the step-by-step transmitter controlling the repeaters. The detector, which operates on the flux gate principle, consists of an annular ring of mumetal resting in a casing around which is a primary winding with two superimposed diametrically opposite and cross-connected secondary windings. The coil assembly is in a plastics housing under which are four slip rings and a fifth for anchoring the cross-connections of the secondary windings.

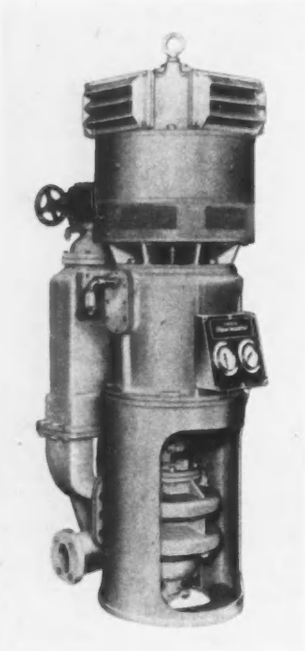
In operation, the coil is energised to saturation by a potential of 2V to 3V at 200 c/s, so that the flux pattern is distorted, thus doubling the frequency. However, no current flows until the compass magnet moves from the null point, when about 5mV to 10mV, 400 c/s, is generated per degree of rotation.

Steering repeater and pedestal

SHORTER REPORTS

Marine Centrifugal Pumps

A RANGE of centrifugal pumps, designed for compactness and accessibility, has been developed by J. H. Carruthers and Co., Ltd., and has successfully completed tests at sea. The pumps, one of which we illustrate, are manufactured in sizes from 3in to 9in diameter suctions, with outputs from 10 to 500 tons per hour against heads varying from 30ft to 450ft, and are available



One of the range of "Flowmaster" centrifugal pumps

as single or two-stage, self-priming units, single or double-stage standard units. They are produced with impellers in series, giving twice the rated head ; impellers in parallel, giving twice the rated output, or impellers in series/parallel, with changeover cock for dual duty. The impellers are of a new design, not dependent on close clearances for efficiency, and no air exhauster is required for the self-priming models, while the only moving parts, apart from the normal rotating assembly, are the diaphragm recirculation control and spring-loaded air release ball valves. The primary tank gives efficient air separation and forms an integral part of the assembly, and the casing is split vertically so that the pump can be opened up without disturbing pipe connections. A double bearing shaft, incorporating a plastic lower journal, is fitted, and also a mechanical seal to eliminate repacking of the stuffing-box.

Cast iron or gun-metal is used for the casing, the rear half of which incorporates suction and delivery passages. The framing housing the pump is fabricated from steel plate, the primary tank is of cast iron, while gun-metal or aluminium-bronze is used for the single entry shrouded main impeller with which is combined an auxiliary priming impeller. An upper ball bearing and a bottom self-lubricating bearing carry the stainless steel shaft.

For priming, liquid is fed by gravity from the primary tank to the impeller, which accelerates the flow into the main discharge and it is then recirculated. During this process a pressure drop is induced in the main impeller suction intake and air is therefore drawn from the suction pipe and discharged through the air release valve on the priming tank. This continues until the liquid is drawn into the impeller, when the priming cycle is automatically cut off. After the priming stage, the liquid is discharged at high velocity from the main impeller and passes up the main discharge pipe to the contact reflux control valve, on the top of the priming tank. The pressure of the liquid closes the valve, thus stopping the priming flow and preventing any loss in efficiency.

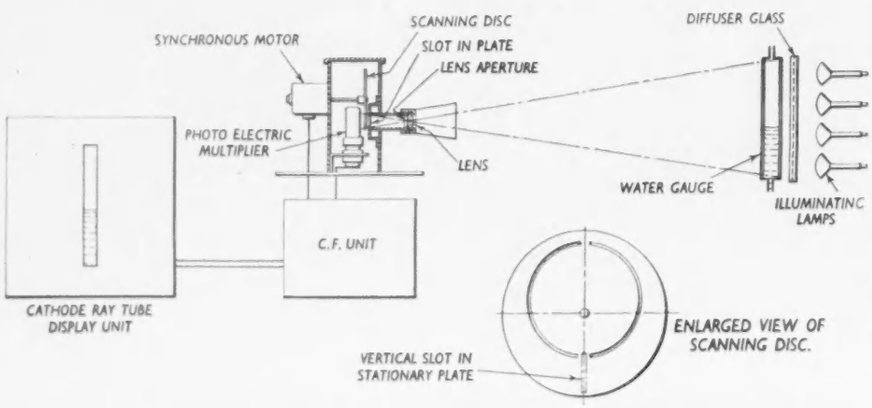
"Television" Equipment for Boiler Water Level Checking

PARTICULARS have been received from Hopkinsons, Ltd., Huddersfield, of the firm's system of "television" transmission of boiler water gauge levels. This equipment comprises a scanning unit, a cathode follower unit and a display unit, the first two of which are arranged in a single assembly and the third situated some distance away and connected by cables.

The arrangement of the equipment can be seen in the diagram we reproduce. It can be used with a prismatic water level indicator of either plate or "Bulls eye" design, in conjunction with an illuminator fitted to the water gauge. The scanning unit houses a lens, scanning disc and photomultiplier. The scanning disc has a narrow slot with variable radius and is rotated at mains supply frequency by a synchronous motor locked to the mains.

In operation, light from the illuminator associated with the water gauge passes through the prismatic indicator in such a way that the steam space appears as intense clear light and the water column as dull diffused light. The scanning unit is placed so that the light from the gauge passes through the lens to a focal plane coincident with the scanning disc. In front of this disc is a fixed vertical slot, and as the disc rotates, the disc slot and the fixed slot together form a gate admitting light at all points along the fixed slot progressively with respect to time. Thus the gauge glass is "scanned" and the gated light is allowed to fall on the sensitive surface of a photomultiplier. The voltage produced is transmitted to the display unit, and is transformed back into light by the cathode-ray tube. Deflection of the beam of light on the cathode-ray tube is exactly synchronised with the scanning motion.

The photomultiplier is insensitive to the water column in the gauge, since the main light from the illuminator, passing through water, is refracted outside the scope of the narrow vertical slot in the plate behind the lens, and the dull diffused light coming directly through the water column is insufficient to activate the light-sensitive cell of the multiplier.



Diagrammic arrangement of water gauge levels "television" equipment in a boiler installation

New Data Processing System for Harwell

A "TRANSISTORISED" data recording and analysing system has been developed by E.M.I. Electronics, Ltd., Hayes, Middlesex, in conjunction with the United Kingdom Atomic Energy Authority, to assist scientists and engineers in handling the great quantities of statistical data nowadays acquired from nuclear experiments at the Atomic Energy Research Establishment at Harwell. Continuous monitoring of nuclear experiments for periods up to twenty-four hours' duration is often necessary, and the quantity of data required may involve many millions of separate measurements to accuracies of 0·1 per cent or less. The new system has been designed to meet this need.

The E.M.I. data processing system is made up of a number of self-contained recording units and a central high-speed analyser. The recording units, situated near the experimental rig, take the measured quantities (for example, neutron time of flight, and scintillation counter identity) and convert them into binary-coded digital form. The coded data, at a typical resolution of 0·2 per cent, are then recorded on magnetic tape in parallel form on sixteen channels on 1in wide tape. At the end of the recording run, the tapes are removed from the recording units for high-speed processing on the central analyser. Both the experimental rig—which may well involve a nuclear pile, together with a great deal of auxiliary apparatus—and the recording units are immediately freed for another experimental run.

The analyser handles the tapes at speeds of up to 100in per second, and the digital information is read off the tape at high speed and automatically sorted into ordered array on a ferrite core store. As the information is now in ordered form in this store, it is a simple matter to read it out at speed, and in a sequence suited to any further data processing required. For example, the core store contents can be transferred on to punched paper tape for direct input to a digital computer, and further calculations on the statistical data carried out. Punched card or graphical output from the core store can also be provided.

The system is being applied initially to neutron spectrometry measurements but because of the versatility of the logical design of the system, it is readily adapted to any instrumentation problem where data has to be acquired over a long time, when magnetic tape storage would be attractive. When data is arriving at fast rates, the magnetic recording stage can be by-passed, and after the data has been converted into digital form by the circuits contained in the recording units, it can be directly sorted into the core store of the analyser. The use of a limited range of plug-in printed circuit transistor "cards" leads to flexibility of logical design, along with ease of maintenance.

Hydrostatic Tractor

THERE took place in London last week a demonstration of the development vehicle for the Dowty hydrostatic transmission, a modified Fordson " Major " tractor. The distinguishing features of the Dowty system were made clear in our article on page 910, December 20 last : it will be recalled that it differs from the Lucas equipment principally in that the pump output is varied by rocking the entire cylinder block and not merely the swashplate, and from the N.I.A.E. experiments by using a high speed geared motor. We understand that this latter characteristic stems from the desire to render the system easily acceptable by established tractor manufacturers, who will, for instance, already have production plant for final drive gears. Similarly, the use of wheel motors would probably compel the designer to change to a system of track variation by moving the complete wheels, since the very large hubs might foul the crops if the rims were set inside or outside them. Another advantage of the geared single-motor drive is that existing differential lock devices can easily be employed to suppress wheel-spin.

Our illustration shows the arrangement of the transmission in the full scale experimental vehicle. The pump pivots about a transverse axis, one end of which is defined by the large pipe union seen directly below the fuel tank. The servo moving the pump can be seen projecting through the top of the main casing, fed by flexible hoses : it is controlled by the push-pull rod running to the lever seen in the vertical position. Also connected to the pump output control, by the flat, dog-leg connecting rod, is a large adjustable piston-type damper : this is purely to resist rapid movement of the pump control, the pneumatic governor being too slow in its response to prevent the engine being stalled by an abrupt application of full load. The servo system runs at the low pressure supplied by the small gear pump seen on the front of the casing below the crankcase : this pump pressurises the main hydraulic circuit. Two large filters, one of which can be seen on the off side of the engine, are included in the low pressure circuit. To suppress any tendency for the tractor to creep at " neutral," the valve block seen in front of the tyre can be opened.

The system has, we are advised, proved satisfactory running on a relatively inexpensive straight engine oil. At the demonstration the ease of control was made manifest : particularly impressive was the high acceleration when full ahead was selected with the tractor unloaded, since with a certain amount of skill the engine could be kept at both high torque and high speed until full speed was reached.

Heating Coils For Tankers

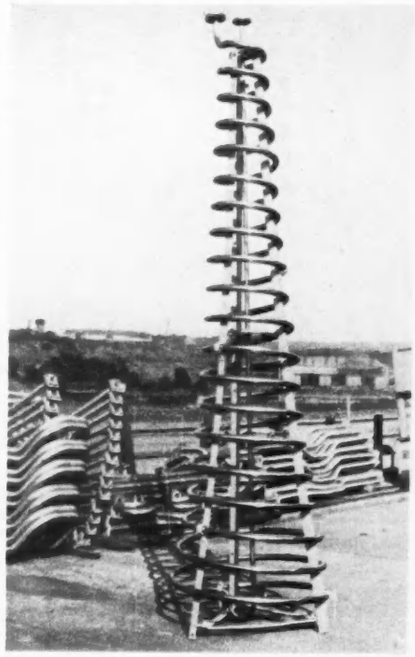
PARTICULARS have been issued by Steels Engineering Installations, Ltd., Crown Works, Sunderland, of some of the firm's more recent developments in connection with heating coils for bunker and cargo tanks in tankers. The " Alabrass " heating system recently introduced uses an aluminium brass tubing which has good heat transmission properties and is highly resistant to corrosion. The system consists of a number of relatively small diameter parallel pipes running longitudinally on the tank bottom between large diameter steam and condense headers. By reason of the parallel flow of steam through a multiplicity of heating pipes, a short steam travel is obtained with adequate terminal pressure for the rapid clearance and lifting of condensate from the condense header to the deck.

The firm is also now making aluminium alloy heating coils which have advantages in lower manufacturing and installation costs and light weight. A recent development in the application of these " Alacoil " aluminium alloy tube heaters is a portable heating grid in block form, as shown in one of the illustrations on this page. These block units can quickly and easily be installed and removed from a cargo tank. The units so far made by the company are about 30ft by 9ft and comprise a frame of aluminium extruded channel sections with the " Alacoil " tubing running round the top and under-sides of the frame.

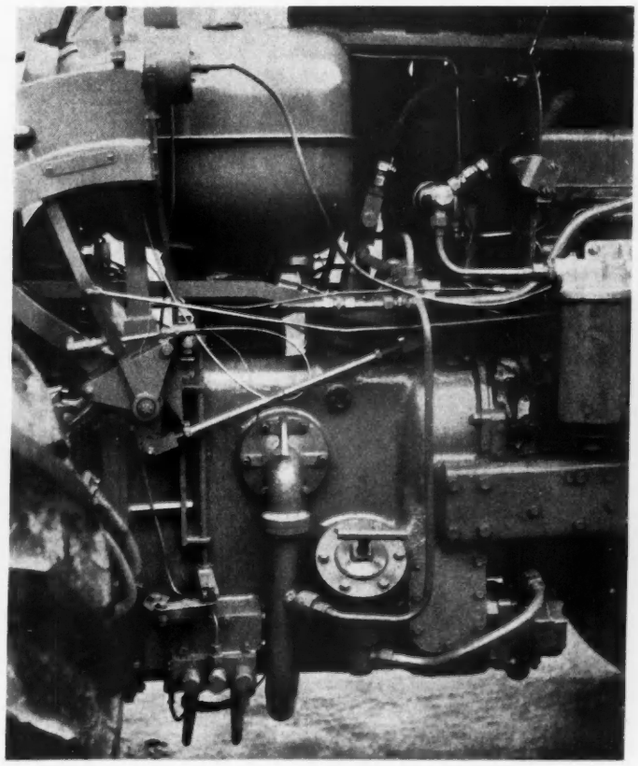
The unit is fixed centrally in a cargo tank and connected to the steam supply and exhaust at the bulkhead; when not in use it is fixed to the top of the hatch cover. The entire frame and installation is fixed to the bottom of the tank by insulated bolts and rests on pads giving complete insulation from the tank and ship's shell. When it is required to use holds for ore cargo, the grid flanges are released, eight bolts removed and slings attached to four bridles, which form part of the centre aluminium frame, and the complete unit can then be lifted out of the tank. These portable grids can be fabricated from aluminium brass tubing or mild steel if cathodic protection is required.

Steels Engineering Installations, Ltd., has also acquired a licence for the manufacture of the helical or conical design of heating coil developed by the Shell Group. One of these coils is illustrated on this page ; they are a complete departure from the conventional coil grids on tank bottoms as hitherto used in tanker heating systems. The new heaters comprise a number of vertical spirals, the number being dependent upon the cargo carried and the size of each tank. They naturally differ in height, diameter, number of spirals and pitch distance, The helical elements decrease in diameter from base to head for efficient cumulative effect of convection currents in the liquid over wide areas ; and to eliminate water-logging, each element has a separate condensate outlet.

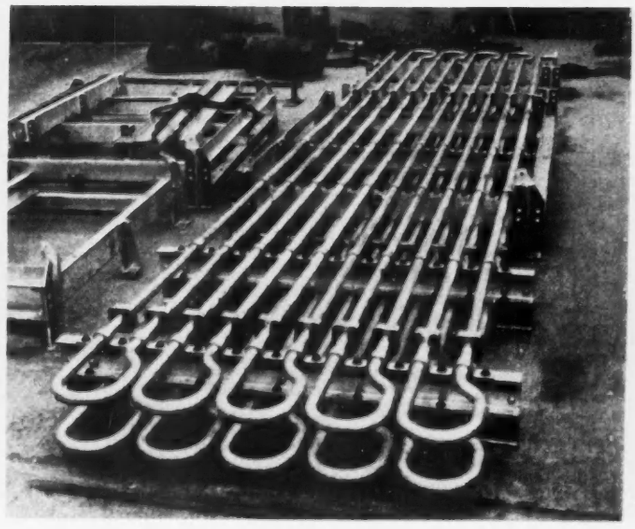
Maintening oil cargo at a temperature approximating to pumping temperature showed very definite economies in steam, by comparison with the normal procedure of heating up from cold shortly before for discharging.



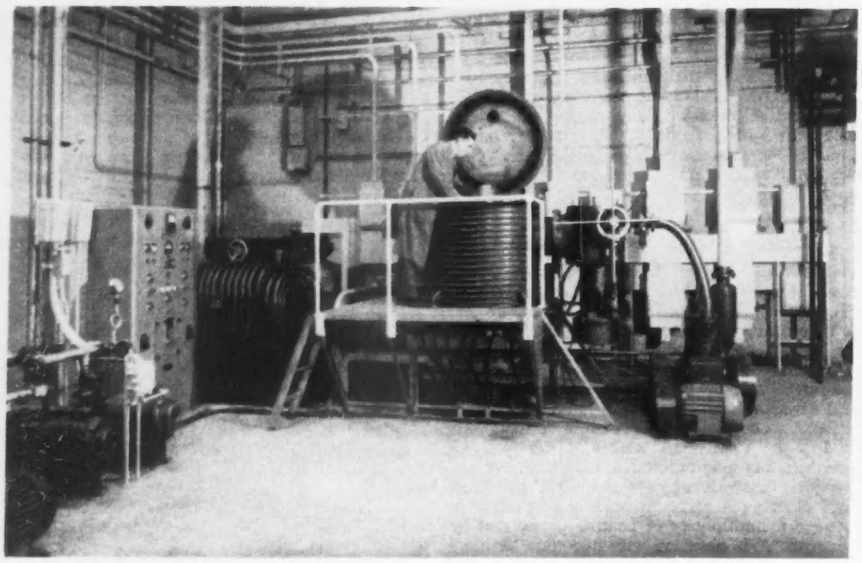
Helical heating coil made of aluminium brass tube



The controls for the hydrostatic transmission are seen here on a modified Fordson tractor



Portable heating coil grid designed for easy installation or removal from a tank



Vacuum furnace rated at 120kVA and having a normal operating temperature of about 1200 deg. Cent.

Vacuum Furnaces

SPECIAL heat treatment processes at the Witton rectifier works of The General Electric Company, Ltd., can now be completed in vacuum, with the recent installation of two vacuum furnaces.

The larger of these furnaces, which can be seen in the illustration above, has usable dimensions 24in high and 15in diameter. Its body comprises a water-cooled, vertical, cylindrical tank of mild steel which is clad on the inner surface with stainless steel. It is covered with a hinged, domed lid operated hydraulically, and faced flanges with rubber seals on the lid and the body of the furnace form a vacuum-tight seal.

The furnace element is an annular assembly of graphite bars and it surrounds the charge which is heated by radiation. This element operates at a low voltage supplied by a three-phase transformer, the output of which is smoothly variable by a voltage regulator to give control over the heating rate. The thermal insulation consists of radiation screens of stainless steel and molybdenum sheets arranged to enclose the heating chamber.

The vacuum pumping system consists of a gas ballast pump, a combined booster and oil diffusion pump and a valve block which controls the evacuation of the furnace chamber. The valve block is fitted with a five-position operating lever which can be moved in one direction only to ensure the right sequence of operations. It is stated that an operating vacuum better than 10^{-4}mm Hg. can be obtained. The gas ballast pump is interlocked with the power supply so that a failure of the pump automatically causes an interruption in the electric supply to the element.

Cooling water for the diffusion pump circuit is taken directly from the mains and that for the heating and cooling cycles from a recirculating water system with a 300-gallon storage tank. The temperature of the water pumped round the circuits is governed by a thermostatic valve in the pump line. As the temperature of the water approaches 120 deg. Fah. the valve opens to allow water to run to waste and cold water from the mains to enter the tank. The cooling circuits are fitted with water flow switches which cut off the power supply to the elements in the event of a water stoppage. A failure of the water pump would also cut off the element supply and, by opening a magnetic valve and temporarily running water to waste, maintain an emergency gravity-fed supply of cooling water through the furnace from the make-up and storage tank.

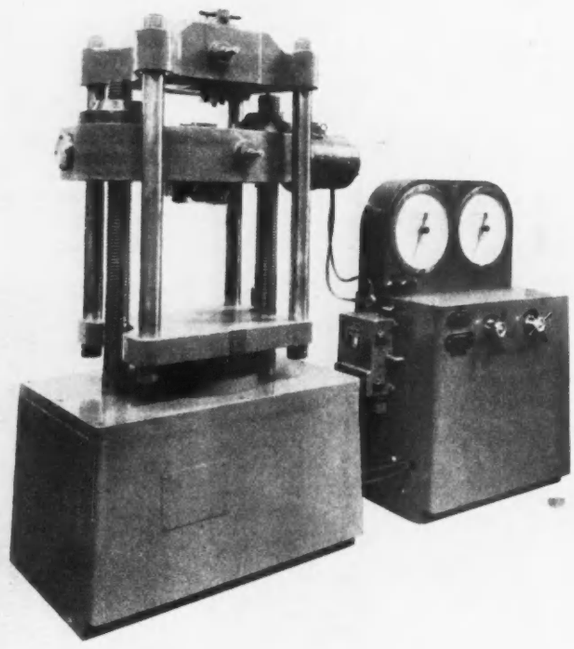
The furnace is rated at 120kVA which allows for rapid heating, if necessary, to the normal operating temperature of around 1200 deg. Cent. The other furnace, which is generally of similar design but has usable dimensions 12in high and 9in diameter, provides temperatures up to 1800 deg. Cent.

Heavy-Duty Flash Butt Welding Machine

PARTICULARS have been issued by A.I. Electric Welding Machines, Ltd., of Inverness, of a new heavy-duty flash butt welding machine. This combined tube and general-purpose machine has a maximum welding capacity of 12 square inches (sectional area) in mild steel, and incorporates provision for welding tubes up to 6½in diameter. A fettling unit can be fitted to the right-hand end of the machine to remove internal weld upset when welding short tubes to longer lengths.

The machine has one fixed and one sliding clamping head, operated from a two-stage air/oil intensifier system from 80 lb to 100 lb per square inch air supply. Initial low pressure, direct from an air cylinder, applies a load of 1 ton, which is intensified to 27 tons for final clamping purposes. The 6in vertical clamping stroke available allows for a wide variation in size and shape of workpiece. Vertical and horizontal adjustment under full clamping pressure is available on the left-hand head for accurately aligning the tubes or components to be flash butt welded. The forging unit uses the same air/oil intensification principle to apply a pressure of 18 tons.

Preheating may be accomplished manually by means of a control lever which reciprocates the sliding clamp unit so as to make and break contact between the mating surfaces, or, alternatively, for batch production, automatically as part of a preset work cycle. The 350kVA water-cooled single-phase transformer for the machine is mounted separately at the rear to give easy access for maintenance and adjustment to a range of secondary voltages which are suited to a wide general-purpose programme.



400,000 lb capacity hydraulically-operated testing machine with smoothly variable testing speeds up to 2in per minute

Hydraulically-Operated Testing Machine

WE are informed by Edward G. Herbert, Ltd., of Atlas Works, Chapel Street, Levenshulme, Manchester, 19, the manufacturer of the Tinius Olsen testing machines under licence in this country, that after having built a considerable number of the smaller capacity machines, it has just completed the first 400,000 lb capacity machine. This machine, illustrated in the photograph reproduced below, has the complete hydraulic and mechanical systems enclosed in a welded frame. It provides for tensile and compression tests by the use of standard equipment of flat grips, vee grips and a compression plate. A range of accessory testing tools are available to cover transverse, shear and bend tests.

On this machine loads are indicated on two 16in diameter precision hydraulic gauges which are mounted on the instrument panel above the hydraulic and electrical controls. The pressure which actuates the gauges is developed in a ground and lapped piston and cylinder, which work without packings and have a slight film of oil separating the moving surfaces at all times. With this design, friction is held to minimum so that the load is weighed within close limits, the machine being built to Grade "A" accuracy in accordance with B.S. 1610, Part 1 : 1958. Load application is accomplished by a hydraulic piston and cylinder located in the base of the machine, the load being applied to the specimen by motion of the piston. The hydraulic pressure system is supplied by a motor-driven gear pump, which, in combination with an automatic valve, provides uniform rates of load application. A safety valve and electric limit switches protect the gauges from overload.

Normally, a stepless range of testing speeds from 0in to 2in per minute is obtainable, the speeds being controlled by two 8in diameter pilot hand wheels, one for loading and the other for unloading the system. With this form of valve control, loads may be easily applied, removed or held constant.

Industrial and Labour Notes

Overseas Trade

According to provisional figures issued by the Board of Trade, the value of United Kingdom exports in November, at £291 million, was higher than in any month since May, 1957. Imports, at a value of £313,100,000, were lower than in the preceding month. The value of re-exports was £12,900,000 and the visible trade deficit at the end of November was thus £9,200,000, the lowest figure recorded this year, apart from May, when the figures were abnormal because of the effect of the dock strike.

The Board of Trade says that when the two months, October and November, are considered together exports were much the same in value as in the corresponding period of last year, but they were 5·5 per cent above the average for the first nine months of this year. Imports were 4·5 per cent less than a year ago, but 3 per cent above the monthly average for January–September this year.

At the annual meeting of the British Council for the Promotion of International Trade, which was held in London last week, the president, Lord Boyd-Orr, urged that the time had come "to have another look at East–West trade." In recent years, he said, the main advances in British overseas trade had been with the industrialised countries. Now, Russia, China and some of the Eastern European countries were being industrialised at a great pace. This gave enormous scope for rapid expansion of trade to those who chose to take it. The opportunity, Lord Boyd-Orr added, came at a time when many other markets were proving disappointing and when this country's foreign trade as a whole had begun to decline. He went on to advocate that Britain should now work out a trade agreement with the Russians, not for a "puny amount," which would merely give a form to the trade that was already being done, but "a bold and ambitious programme at least to double our trade with the U.S.S.R. in 1959."

Capital Investment Programmes

In an article entitled "Can We Control the Economy" in the December issue of the *District Bank Review*, Professor C. F. Carter deals, amongst other matters, with direct control of capital investment programmes. In recent years, he says, the main area of direct control over specific investment programmes has been the nationalised industries, which have had their "permitted level of investment" moved up and down in a most bewildering manner. The changes made have not always been related to the desired trend of investment as a whole; thus, the 1957 cut in British Railways investment was partly restored in 1958 as part of a bargain in a wage settlement.

It is sometimes suggested, Professor Carter continues, that a similar control of programmes should be extended to private industry, either by requiring large firms to state their intentions and alter their plans at Government direction, or by using instruments such as the licensing of industrial building. Professor Carter then goes on to express grave doubts about that kind of control. It may be, he remarks, that the necessary economic control could be achieved through variations of social investment or "public works." But even that is much more difficult in detailed practice than it appears in broad theory. Much social investment has been undertaken in response to a need generally felt to be urgent (the school building programme is an example), and it could not readily be varied in its pace. Even where variations are possible, Professor Carter says, they would commonly cause much waste unless they are planned well in advance.

Iron and Steel

The latest monthly report from the Iron and Steel Board shows that during November there was a further small decline in the iron and steel industry's production. Pig iron output averaged 233,700 tons a week, compared with 241,900 tons a week in October, and 281,500 tons in November, 1957. Steel production in November averaged 351,900 tons a week, compared with 363,500 tons in October and 429,200 tons in November last year. The Iron and Steel Board says the decline from the October output figure was caused principally by the reconstruction of a slabbing mill at one of the major works which interrupted production for about ten days. But for that event, it is thought that the level of production would have followed the trend of the third quarter, namely, at about 16 per cent below last year's level.

The Board goes on to say that the liquidation of stocks which began towards the end of the second quarter of this year, led, during the third quarter, to a fall, equivalent to 365,000 ingot tons, in consumers' and merchants' stocks of finished steel. Industries showing a particularly heavy fall in stocks, ranging from 10 to 15 per cent, include shipbuilding, building and constructional engineering and private manufacturing of railway rolling stock. In contrast, the electrical industry and the motor-car industry increased their holdings of steel during the third quarter. But, the Board remarks, the current low level of steel production in relation to industrial activity suggests that the reduction in consumers' stocks is continuing.

The Board now estimates that, after allowing for the fall in stocks, steel consumption in the third quarter of this year was 6·9 per cent below that in the comparable period of 1957. The fall in consumption from last year's level ranges from 7 per cent in the case of shipbuilding to 35 per cent in the case of private makers of railway rolling stock. For industries making "intermediate" goods, such as bolts and nuts, the decline is of the order of 20 per cent, for the engineering and constructional industries generally it is about 15 per cent and for the nationalised industries, about 9 per cent. In contrast to the recession in the investment goods industries, consumption in the metal furniture and hollow-ware industries is higher than it was a year ago. Steel consumption in the motor industry, which includes also commercial vehicles, tractors and cycles, was about 7 per cent lower in the third quarter of this year than it was in the corresponding period of 1957.

Employment and Unemployment

The Ministry of Labour has estimated that, during October, the number of people in civil employment in Great Britain declined by 21,000 to a total of 23,076,000 (15,269,000 men and 7,807,000 women). The principal changes were seasonal ones, reductions being reported in hotels and catering, transport and building and contracting, while in the distributive trades there was an increase in the number at work. There was a reduction of 4000 in the number of people employed in the manufacturing industries, most of the decline occurring in the engineering, metal goods and scientific instruments group. In that group, the total employed at the end of October was 2,778,000, compared with 2,854,000 a year earlier. The number employed in vehicle building has also declined in recent months; at the end of October the total was 1,230,000, compared with 1,246,000 a year earlier.

About unemployment, the Ministry's report states that on November 17 there were 536,027 people registered as out of work, compared with 513,842 on October 13. The November figure represents 2·4 per cent of the total number of employees. The November registrations included 483,000 who were wholly unemployed and 53,000 who were temporarily stopped. Of the wholly unemployed, 238,000 had been out of work for more than eight weeks. The employment exchanges filled 151,000 vacancies in the five-week period ended November 12, the number of vacancies notified but remaining unfilled being 159,000. That was 7000 fewer than in October.

Nickel in 1958

Dr. J. F. Thompson, chairman of The International Nickel Company of Canada, Ltd., says, in a review of the industry, that this year the free world has attained a new record in annual nickel production capacity, estimated at about 525 million pounds. Total nickel consumption in 1958 in the free world is expected to be between 325 million and 335 million pounds, compared with about 415 million pounds last year. The principal cause of the decrease, Dr. Thompson remarks, has been the recession in the U.S.A. and Canada which has had a particularly strong effect on the production of durable goods. Because this coincided with a period of heavy stock liquidation by consumers, this year's nickel deliveries in all forms have been appreciably lower than consumption. But in the United Kingdom and on the Continent, Dr. Thompson asserts, there has been only a slight decrease in the consumption of nickel.

Dr. Thompson goes on to say in his review that to-day's free world annual nickel production capacity of about 525 million pounds is expected to rise progressively in the next few years. It is estimated that production capacity will reach 550 million pounds next year, about 600 million pounds in 1960 and 650 million pounds in 1961. It is significant, Dr. Thompson comments, that the projected 1961 nickel production capacity will be about double the free world nickel consumption during 1958. A substantial part of the estimated production increase by 1961 is likely to come from the International Nickel Company's Thompson mine in Manitoba which has been under development for the past two years.

As to the future, Dr. Thompson points out that nickel consumption in recent months has shown an improvement over the low levels touched earlier this year; it is expected that the improvement will continue in 1959. But, he adds, the nickel industry is entering into a period of vigorous competition. During the past period of nickel shortage, producers of competitive materials have naturally taken advantage of the fact that large quantities of nickel were required for defence production and government stockpiling. Substantial inroads were consequently made into traditional civilian markets for nickel.

South African Railway Electrification Progress

BY OUR SOUTH AFRICAN CORRESPONDENT

THE latest estimates of the approved electrification programme adopted by the South African Railways Administration show that the total expenditure will amount to approximately £37,000,000. Whilst electrification is an extremely important aspect of traction, it does not mean the end of the steam locomotive, which will continue to be extensively used, and the diesel traction programme of the railways is also comprehensive. The following is a short summary of the present position in each of the four provinces of the Union.

Orange Free State

Electrification work in the Orange Free State is well under way on the 121-mile Vereeniging–Kroonstad section, the first line to be electrified in this province. The doubling of the line was completed in 1956. Foundations for the overhead masts have been completed between Kroonstad and Coalbrook and work on the Coalbrook and Vereeniging section is now in progress. Wiring has been started between Coalbrook and Koppies.

Natal

The programme in Natal has reached an advanced stage, and the end of this year should see the completion of the work. At present, tunnelling between Boughton and Merrivale is retarding the doubling and electrification of the Natal main line, but once this has been completed the rest of the work will present no problems.

In April, 1956, the electrifying of the single line between Rossburgh and Cato Ridge, a distance of 40 miles, was started, and this work should be finished soon. All work on foundation laying, the construction of steelwork and masts and the wiring has been done, while the substations are at present under construction.

Once this line has been electrified it is expected that the bulk of the present main line goods traffic will be diverted over it while passenger traffic will be concentrated on the present main line. It is of interest to note that part of this line, the section between Rossburgh and Hillcrest, was due for electrification in 1938, but the project was interrupted by the war, shortly after work had started. However, some of the material installed at that time can still be used on the present project.

With the completion of the electrification programme in Natal, this province will have 400 route-miles of electrified lines.

Cape Province

In the Cape, a distance of 210 route-miles is being electrified, and the most important section still to be done is the main line between Touwsrivier and Beaufort West, a distance of 179 miles. This is the longest single stretch of electrification ever to be undertaken by the South African Railways and the work will take nearly four years. Depots have been established at Beaufort West and Laingsburg, and from now on construction will go ahead at full speed, as the preliminary work has been completed.

The electrification of this stretch of main line will bring about a great improvement in the movement of traffic between Johannesburg and Cape Town. The present carrying capacity will be nearly doubled, from about 19,000 tons to more than 32,000 tons per day. In addition, operating costs will be greatly reduced. Train loads can be stepped up from 944 tons to 1560 tons, and apart from the fact that coaling and watering are unnecessary on electrified sections, electric units do not entail the handling problems associated with steam locomotives. When electricity takes over on this section the condensing-tender locomotives now stationed at Touwsrivier will be moved to Beaufort West, de Aar and Beaconsfield, for use between these points.

Electrification of the Matroosberg–Kleinstraat section, a distance of 6¼ miles, on the Cape Western main line between Bellville and Touwsrivier, has just been completed. Good progress is being maintained on the electrification of the new non-European suburban lines, Langa–Athlone, Athlone–Dieprivier and Cape Town–Nyanga, a total route mileage of twenty-two. Work on these projects has been in progress now for nearly two years. The section Athlone–Dieprivier has been completed, while that between Cape Town and Nyanga will be completed early next year and Langa–Athlone in December, 1960.

Transvaal

A total of 302 route-miles is being electrified in the Transvaal. One of these projects, Springs–Welgedag (6 miles), has been completed and the Apex–Rangeview–Dunswart section in the Germiston area has been placed in service, as well as the 58-mile stretch between Welverdiend and Klerksdorp.

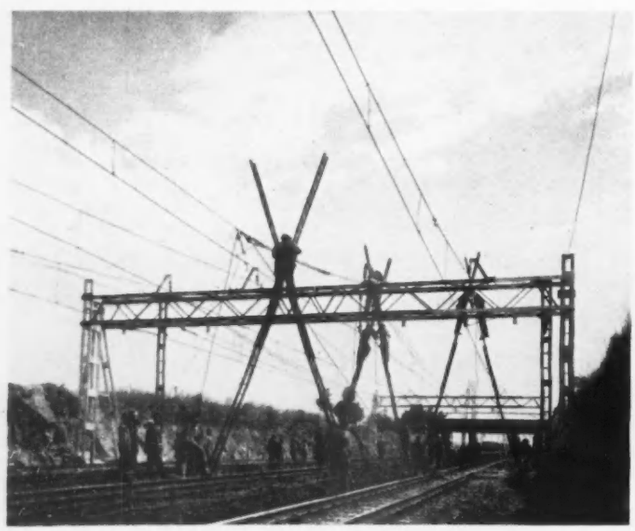
All the electrification projects in the Pretoria area should be completed during this year, including the Eerste Fabrieke–Koedoespoort section which was started only recently. The section Pretoria–Koedoespoort and the new Atteridgeville–Cordelfos line have been completed.

In the Johannesburg area good progress is being maintained on the building and electrification of the various new non-European lines. The New Canada–Dube line has reached the halfway stage and is scheduled for March, 1959. The Dube–Doornkop section will be completed at the end of this year, while the Crown–West Street double line, which is only 1¼ miles long, should be in service by the same time. The photographs we reproduce were taken in the New Canada area and give some idea of the methods and equipment employed in the work in general.

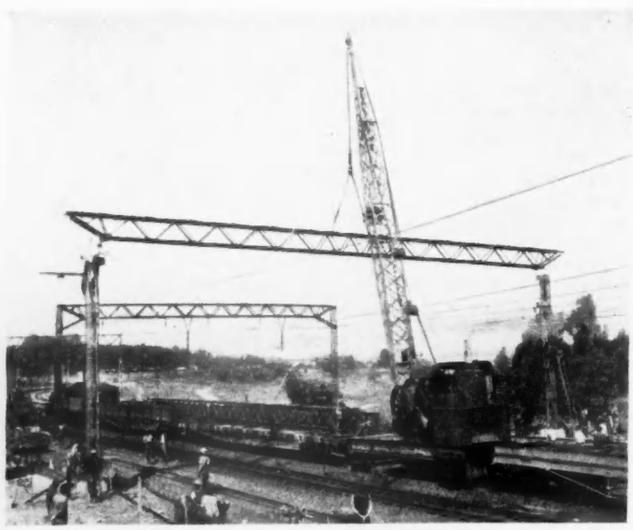
Around Vereeniging, electrification has also reached the half-way stage, and the 29-mile stretch between Midway and Vereeniging will be placed in service towards the end of this year or early next year. The section Wattles–Vereeniging (34½ miles), which is being undertaken in conjunction with the programme of electrification for the Orange Free State, is due for completion in February next, and when the section between Vereeniging and Kroonstad is finished there will be an electrified double line all the way from Broodsnyersplaas in the Eastern Transvaal to Kroonstad, a distance of 222 miles. There will also be an electrified line all the way from Johannesburg to Kroonstad.

Except for the India Junction–Elsburg section, where the quadrupled lines are being electrified, work in the Germiston area should be finished by the end of 1958. The doubling and electrification between Dunswart and Alliance, which was started in 1956, should also be completed this year, as well as the new non-European double line between Alliance and Daveyton, and the Angus–Germiston East new double line.

In the Eastern Transvaal the coal lines between Witbank and Welgedag and Broodsnyersplaas are also being electrified. Work on the Broodsnyersplaas–Oogies section, which was started in June, 1957, is due to finish in October, 1960.



Traction linesmen working on the newly quadrupled line near New Canada



A mobile crane lifts a mast member into position near New Canada station

Fifty Years of Tata Iron and Steel Company

BY OUR INDIAN CORRESPONDENT

THE Tata Iron and Steel Company, which celebrated its Golden Jubilee this year, was founded by Mr. Jamshetji Nusserwanji Tata fifty years ago, although Mr. Tata, who died in Germany in 1904, did not live to see the day when the first ingot of steel came off the line at Jamshedpur steel works in 1911. The company was started with an initial capital of Rs.2.32 crores, wholly subscribed by Indian investors. Actual construction activities commenced in 1908, which included not only the building of a steel works but also a modern township in the heart of Chhotanagpur jungles in Bihar. The initial capacity of the plant was 160,000 tons of pig iron and 50,000 tons of finished steel per year. In the early ninteen-twenties, the annual steel-making capacity was increased to 450,000 tons and, later, to 1,000,000 tons by 1940. By the end of 1958, the capacity will be doubled to 2,000,000 tons of ingot steel a year.

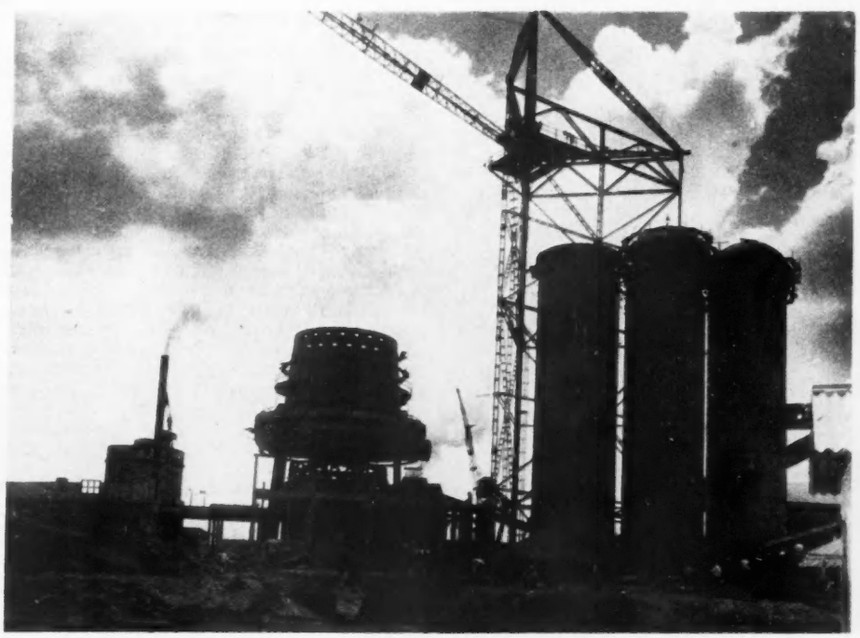
Before the Tata Steel Company came into existence, a number of attempts had been made in different parts of India to start the steel industry by both private companies and the Government. Furnaces were set up at Porto Novo, Salem and Beypur in the south, in the Kumaon Hills of Uttar Pradesh, Warora of Madhya Pradesh, Indore in Central India, and in Birbhum and the Raniganj coalfields of Bengal. Many of these ventures produced saleable pig iron of good quality but all of them except the Bengal Iron Works had to close down. The latter, after a short spell of Government ownership, passed into the hands of the Bengal Iron and Steel Company in 1899, and was amalgamated with the Indian Iron and Steel Company at a much later date. The reasons why these iron works were unable to pass beyond the stage of pig iron production were, first, lack of proper planning in the production and procurement of raw materials and, secondly, lack of technical know-how. Mr. Tata set out to rectify this by launching on an ambitious prospecting programme, although for some twenty years he could make little headway because of the restrictive mining laws on the Statute Book at the time. Eventually he prevailed upon the Secretary of State for India to give prospectors a fair deal. The search for iron ore set in motion by him led to the discovery of the Dhalli-Rajhara deposits in Madhya Pradesh and of the great hills of iron in Mayurbhunj, Keonjhar and the Singhbhum district of Bihar. The discovery of these deposits, which reputedly contain the world's greatest reserves of hæmatite, the highest quality iron ore, has been described recently as Mr. Tata's "undying contribution to India." The Tata geologists decided against locating the steel works at Dhalli-Rajhara, as coking coal was then available only from Jharia and Raniganj, over 500 miles away, but sixty years after the discovery, the ore will be utilised by the Bhilai steel works near Durg, one of the Government steel works under the Second Five-year Plan.

By the end of 1911, the plant was ready to go into operation. It consisted of two blast-furnaces, a steam-driven blooming mill, and a rail and structural mill. The first ingot was rolled on February 16, 1912, and the plant had attained enough capacity by 1916 to meet the World War I demands. With the end of the war, the Indian market was flooded with cheap Continental steel, which threatened the growing Indian steel industry with virtual extinction. In 1924, as a result of the recommendation of the Tariff Board, a small protective duty was granted for three years. In 1927, the next major tariff inquiry was held which resulted in the abolition of the prevailing system of bounties and the formulation of a revised scale of protective duties for the next seven years. During the depression of the nineteen-thirties, the industry all but died a slow death, and it was not until 1935 that the Tata Company was able to restore the meagre ordinary dividend which it had stopped paying for the best part of a decade. The production figures during this unsettling period are interesting : in 1923, at the time of commencement of protection, Tata Steel's output stood at 156,000 tons. By 1927, it had increased to 530,000 tons. During the next seven years, production rose every year (although prices were declining), reaching 834,000-ton mark in 1934. This helped to cut down imports from 75 per cent of the country's requirements in 1927–28 to about 38 per cent in 1932.

During World War II, the Indian steel industry was directed to concentrate its attention on meeting war needs. Tatas manufactured special steels for bullet-proof armour plates and armour-piercing shots, and supplied over 3,000,000 tons of steel in over 110 varieties to Government for use directly and indirectly connected with war purposes. Simultaneously, production was diversified. A plant for the manufacture of wheels, tyres and axles was set up in 1941. Towards the end of the war, manufacture commenced of electrical steel sheets of dynamo grade and a little later of transformer grade sheets. During the war, the works achieved a peak production of 1,237,000 tons of pig iron, 1,082,000 tons of steel ingots and 839,000 tons of saleable steel in one year. The plant, in fact, was over-worked during the war and had to be completely renovated.

It is out of this renovation and modernisation programme that the present 2,000,000-ton project was born. Initially, the modernisation programme had for its objective the raising of the capacity to 1,300,000 tons of ingot steel a year from the post-war 1,000,000-ton capacity. The programme was launched in 1951 and was estimated to cost Rs.25 crores, of which Rs.10 crores were borrowed from the Indian Government. The programme was limited in character ; its aim was to modernise and expand facilities within the existing framework because enough money was not available for anything more ambitious. It included the building of a new battery of fifty-two coke ovens to replace an old one ; five 165-ton open-hearth furnaces ; a 200,000-ton skelp and strip mill to provide the raw material for making tubes and cold-rolled ing mill and plate mill to increase their production from 60,000 tons to 100,000 tons of plates. The skelp mill is perhaps the most important of these, and it was brought into commission in March, 1956. It sustains the growing tube-making industry in the country, of which there are already three units. By far the largest and the most comprehensive of these is the Indian Tube Company's plant at Jamshedpur, jointly sponsored by Tata Steel and Stewarts and Lloyds of the United Kingdom.

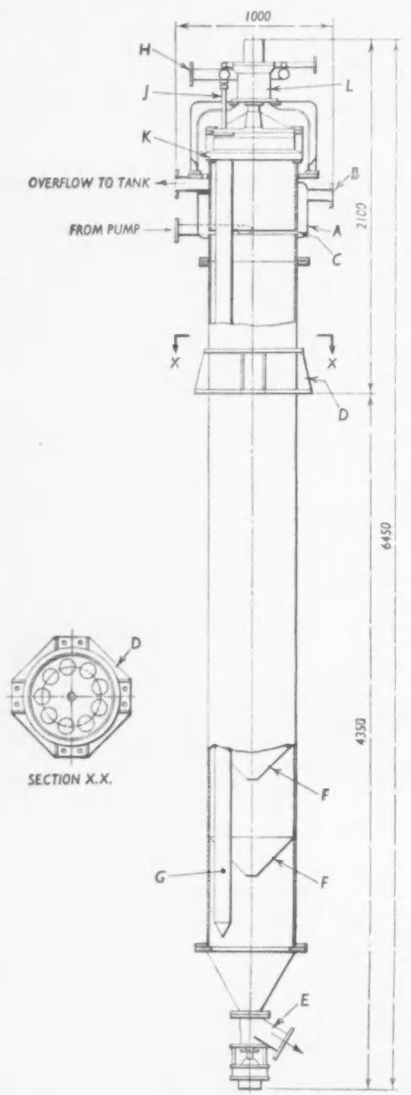
By 1955, the draft outline of the Second Five-year Plan with its emphasis on heavy industries was published, and it was clear that the core of the plan was steel, the production of which was to go up from 1,600,000 to 6,000,000 tons. The three new plants were to have a capacity of 1,000,000 tons each, Tata steel works to double its capacity to 2,000,000 tons, and the other two existing steel works to make up the gap of 1,000,000 tons. The finance for Tata's expansion was arranged as follows : loan from World Bank, Rs.51 crores ; new share capital, Rs.14 crores ; bank borrowings, Rs.10 crores ; loan from the Government, Rs.5 crores, and retained strip, and complete modernisation of the bloom-earnings, including sale of investments, Rs.37 crores. The expansion programme, which is known in Jamshedpur as Two-Million-Ton Programme (T.M.P.), can be said to have begun in December, 1955, when the Tata Iron and Steel Company entered into an agreement with Kaiser Engineers, a division of Henry J. Kaiser Corporation of the United States, to take charge of the designing, procurement and construction of new facilities. The contract, which is scheduled to be completed by May 31, 1958, was worth about 130 million dollars. The programme covers expansion of and improvement in mining of ore and other raw materials, and embraces practically every aspect of the plant from coke ovens to rolling mills, including expansion in services such as electrical distribution, water, fuel, roads, sewers and transport. The principal items included in T.M.P. are a battery of coke ovens ; a new blast-furnace with 28ft hearth (illustrated) designed for top pressure operation ; a sintering plant of 5000-ton capacity (per day) ; three new rolling mills—a 46in blooming mill, a medium and light structural mill, and a sheet, bar and billet mill, &c. The project currently employs 10,000 Indians and ninety specialist American engineers. The work is proceeding according to schedule.



Blast-furnace "F" under construction

Continuous Flow Crystalliser

A SWINGING crystalliser based on the invention of A. E. Zdansky has been placed on the market by Giovanola Frères S.A., Monthey/V.S., Switzerland. The apparatus permits crystallisation by cooling from a continuously flowing solution. It is made in three sizes. The smallest size is for pilot experiments requiring a throughput of 50 to 150 litres per hour (cooling area 0·5 square metre); the next size is for medium-scale production with a throughput of 0·4 to 1·5 cubic metres per hour (cooling area 6 square metres); finally there is a large apparatus for a flow of 0·6 to 3 cubic metres per hour, having a cooling area of 12 square metres. Higher outputs may, of course, be reached by arranging several machines in parallel.



Continuous flow crystalliser for a throughput of 0·6 to 3 cubic metres per hour

Our illustration shows the equipment. Hot saturated solution is pumped from a tank to the annular space *A* at the top of the crystallisation column, a constant level being maintained by an overflow *B*. Through the annular slit *C* the liquid reaches the inner surface of the column, which is suspended in a vertical position from the ring bracket *D*. At the bottom of the container is a valve *E* which is opened for a brief moment at intervals of six to ten seconds, by means of a pneumatic impulse of 2 to 3 atmospheres pressure. This lets escape a shot of spent solution, together with a certain amount of crystals. The crystals are then separated from the solution in a centrifuge.

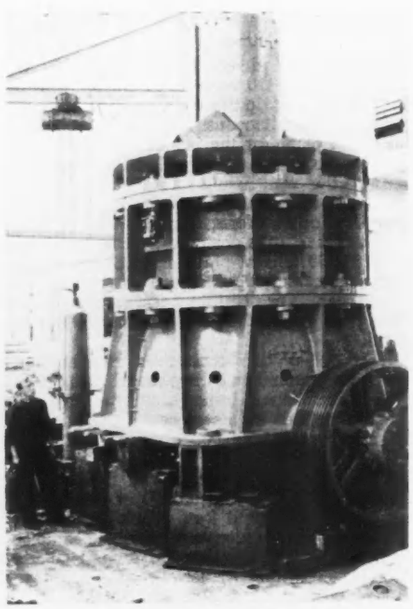
The whole crystallisation chamber is subdivided into compartments by the conical perforated screens *F*, through which pass a number of cooling tubes *G* which are closed at the bottom. Cooling water or brine is fed through the manifold *H* and the central tubes *J* and rises in counterflow in the annular outer space of the tubes *G*. The cooling tubes are supported in an elastically mounted head *K* which receives, from a pneumatic hammer *L*, sharp downward pulses at the rate of one per second. This has the effect of "shaving off" the crystal nuclei which form on the surface, and dispersing them in the liquid, where they continue to grow until they finally reach the bottom of the container. The intermediate sieve bottoms *F* act in the sense of increasing the turbulence during the periods of opening of the valve *E* when the liquid experiences a downward acceleration.

It is stated that under favourable conditions (i.e. with high turbulence even in the bottom region where the crystal content is high) it is possible to achieve a cooling rate of about 200,000 kcal per hour and a daily production of 12 to 15 tons of crystals.

On average, the solution stays in the apparatus for thirty minutes. In order to be able to use the method of crystallisation by cooling, it is therefore essential that the solubility should depend sufficiently strongly upon the temperature. Crystals are obtained in sizes of up to 0·5mm. The concentration of crystals at the outlet must be limited to 20–30 per cent in order that the mixture should still be turbulent. It is essential that the cooling tubes should be given a high degree of polish, so that the crystals which form should come away easily. The best effects are obtained with highly polished chromium-plated surfaces. Operation is continuous and requires dust- and oil-free compressed air of 3 atmosphere gauge, consumption being 12 to 20 cubic metres per hour of free air, depending upon the setting.

Gyratory Crusher

For the underground ore crushing station at the Luossavaara–Kirunavaara AB, Kiruna, eight 600mm gyratory crushers, such as the one shown in the accompanying illustration, have been or are being supplied by Morgårdshammars Mek. Verkstads Aktiebolag, Morgårdshammar, Sweden. These back "Model AR–180" jaw crushers: the latter have an opening of 1800mm by 1400mm and a setting of 400mm, and are driven at an eccentric speed of 150 r.p.m. by a 150 h.p. motor. The Kiruna plant produces about 10,000,000 tons annually.



Gyratory crusher with 600mm diameter opening, for use as secondary ore crusher

The 600mm gyratory crusher has a cast steel frame, consisting of bottom shell, top shell and spider, the spider arms and the hopper chute having guards of manganese steel. The main shaft is a steel forging with central bore. A crushing head of cast steel is shrink-fitted to the shaft; the fixed concave crushing plates are of manganese steel with a zinc backing. The one-piece mantle of manganese steel is zinced to the head and held in place by the main shaft nut. Two SKF spherical roller bearings support the cast steel eccentric. The lower main shaft bearing consists of a SKF spherical roller bearing with widened outer race for easy sliding in the eccentric bore, while the upper main shaft bearing consists of a hemisphere of cast steel supported in a spherical bearing box liner. The cast steel bearing box serves as a ring piston movable in the lined boring of the spider. Oil under pressure holds the piston against an adjusting nut in the spider. By turning this nut, the crusher setting is adjusted. A working pressure of 700 lb to 850 lb per square inch is supplied by a motor-driven pump unit. If the crusher has been over-loaded or tramp iron has entered the crushing chamber, the safety valve opens, due to increased oil pressure. The piston and the main shaft then sink and release the crusher. The shaft returns automatically, and the crusher continues to work, provided the crusher motor has not already been stopped.

The crusher has an inlet opening of 600mm and an open side setting of 100mm. The bottom diameter of the mantle is 1850mm. The motor rating is 200 h.p. at 740 r.p.m. The machine has a net weight of about 93 tons.

5000-Ton Floating Dock

We have received details of a 5000-ton floating dock designed and built at the Pansio shipyards of Valmet Oy, and put into service at the same company's Helsinki yards, earlier this year. The hull consists of three sections so as to be self-docking, the end sections being capable of being docked simultaneously on the centre section, which can itself be supported on the two end sections. With an overall length of 127m, the structure has a docking length of 115·2m, a width of 20·5m and a water depth over keel blocks of up to 7·5m. There are two travelling cranes, one on each side, capable of lifting 5 tonnes at 14m radius. The bilge pumps each have a capacity of 2400 tons per hour, so that lifting a vessel takes about one hour. In addition, there are two trimming pumps capable of discharging 540 tons per hour, and a 60 tons per hour centrifugal pump which serves as a fire pump. The dock has four 5-ton electric capstans. Steam is supplied by an oil-fired boiler, and there are mains for compressed air, acetylene and oxygen. A rectifier has been installed for the supply of direct current.

Non-Slipping Taper Joints

A securing device to prevent slipping of taper joints that hold grinding wheel bosses on machine spindles has been developed by the SKF Company. It is claimed to be simple, inexpensive, and suitable for a variety of applications. The device consists of a coupling-washer having two projecting segments which engage with flats at the small end of the spindle taper. At right angles to these projections the coupling-washer has two flats which fit between two similarly projecting segments on the boss of the grinding wheel. The smooth surfaces of the joint components can easily be kept clean and the symmetrical design eliminates out-of-balance. Because of the angular relationship between the coupling surfaces the washer is self-aligning: thus there is no need for a high degree of precision in manufacture as in the case of conventional keyed taper joints.

National Metal Congress and Exposition

No. II—(*Continued from page* 947, *December* 12)

BY OUR AMERICAN EDITOR

Baker and Co.

THE display of Baker and Co., Newark, New Jersey, included an important development for the electronic valve industry—platinum-clad tungsten wire. In recent years, both the control and screen grids in modern transmitting valves have been designed to employ platinum-clad molybdenum wire. However, with the advent of high-power valves that operate at higher frequencies and higher powers to maintain high efficiency, it was found necessary to decrease inter-electrode spacings, increase grid dissipation, and decrease grid wire diameters to attain these new frequencies and power requirements. This created a need for a more rigid and refractory core material for the platinum wire than molybdenum, which is satisfactory for valves of low frequencies and powers. Tungsten was selected as the core material because of its superior physical properties at elevated temperatures. In addition, tungsten exhibits a substantially lower degree of interaction with platinum than molybdenum does at comparable temperatures. Tungsten or molybdenum is used as core material because a grid made of pure platinum wire would be very costly, but, even more important, at elevated temperatures the softness and inadequate hot strength of solid platinum preclude its use.

Platinum-clad tungsten is usually clad with 24 per cent or 42 per cent platinum by weight. The 24 per cent platinum by weight material is comparable to 0·0006in of platinum on a 0·010in overall diameter. It is readily hot stretched to take a permanent setting and lends itself to fabrication into grids employing conventional fixtures and spot welding procedures. It can be obtained over a range of diameters from 0·001in up. Special tests were made designed to measure the relative sag at elevated temperatures of platinum-clad tungsten as compared to platinum-clad molybdenum, as shown in Fig. 6. At 1000 deg. Cent. very little sag was observed with either material, but at more elevated temperatures a substantial difference was found, with the tungsten core wire being more rigid. For example, at 1200 deg. Cent. the clad molybdenum is found to sag seven times faster than the clad tungsten wire of the same diameter, the total sag for clad tungsten being $^{7}/_{32}$in in thirteen hours. Photomicrographic studies of these two platinum-clad materials revealed that during operation alloying occurs between platinum and molybdenum, showing extensive intergranular penetration by the platinum to a depth of several thousandths into the molybdnum. No such intergranular penetration was observed in the case of the tungsten core wire. Rates of diffusion of atomic molybdenum and atomic tungsten into the platinum were reported to be of the same order of magnitude. Grid emission studies indicated that primary emission from the two materials was substantially the same in grids associated with thoriated tungsten cathodes. This was expected since both materials have identical surfaces. Tests with platinum-clad tungsten grids in high-frequency power transmitting valves showed negligible grid emission and no grid distortion over long periods of life.

Oregon Metallurgical Corporation

The exhibit of the Oregon Metallurgical Corporation, of Albany, Oregon, centred around a new titanium casting technique which is expected to lead to reasonably priced titanium castings. The present general slump in titanium usage has caused the capacity of the American industry to produce titanium sponge and shapes to be greatly in excess of current demand for the metal. But a time of travail like this can also be a time of opportunity. There are now sound and more compelling reasons for taking a careful look at the possibilities inherent in titanium castings, not only for aircraft use, but also for many corrosion-resistance applications. In the past, comparatively little attention was given to the technology of casting titanium. Not only did casting pose awkward technical difficulties ; the high cost of the metal, lowered strength of the cast product, uncertain quality of castings, high mould cost and high scrap loss all offered serious obstacles. The only off-setting improvement in performance to be gained by overcoming all these obstacles was in corrosion resistance. A very serious obstacle was the ready reactivity of the metal with most conventional mould materials, especially in view of the high melting temperature of titanium. This temperature can be expected to drop somewhat as improved casting alloys are developed. The pure metal melts at 3035 deg. Fah., but the alloy 6 Al–4 V melts in a range between 2786 deg. and 2976 deg. Fah. Other alloys with lower melting points can be expected to make their appearance as casting of titanium becomes more general.

Of mould materials, the most reliable is machined graphite. This material holds a close tolerance, may be re-used a number of times and imparts only slight surface contamination. Unfortunately, it is an expensive material to use and is limited in size of casting. It should be regarded as a starting point. In applications in which titanium enjoys clear and marked superiority over competing metals, castings in machined moulds are already proving their worth. But individual successes have been reported with a number of other mould materials, including rammed carbon moulds, shell moulds of carbon bonded with phenol formaldehyde, zircon shell moulds washed with graphite, and zircon impregnated or bonded with titanium powder to make an oxygen-deficient ceramic. Enough work has been done to establish that wide ranges of quality are possible and that quality of titanium castings is related to cost. A low-cost, rough-surfaced titanium casting is feasible of production at a very much lower cost than the high quality, machined graphite mould product.

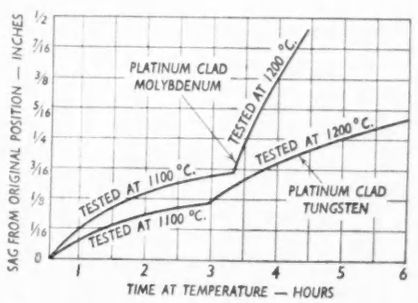


Fig. 6—Relative sag of platinum-clad tungsten and molybdenum wires

The cost of the titanium metal used in casting is also subject to considerable variation. First, there is the variation in quality of scrap. Most of the work to date has been done with good quality sponge as melting stock. Inherent in the present situation is the possibility of exploiting the availability of low-grade sponge, and low-grade scrap for the production of castings having reasonably adequate strength with very superior corrosion resistance. Many of the applications suggested for titanium castings in the chemical industry, to cite only one obvious and outstanding example, are not very highly stressed. Achievement of a reasonably sound casting in titanium, using low-grade scrap and a rammed carbon mould, should bring the product down almost within reach of stainless steel. In view of the very long life of titanium in corrosion service, the favourable economic position of such low-cost castings is obvious.

The Oregon Metallurgical Corporation is now producing such shapes as valve bodies, centrifugal pumps and agitators from titanium, casting them in an expendable, rammed graphite mould composition developed by Du Pont. The new method produces sound, high-quality castings with properties similar to those of forged and rolled materials. In field tests, a 2in cast titanium globe valve outlasted all contenders. Titanium and stainless alloy valves were compared in 65 per cent nitric acid service at 230 deg. Fah., for example. Six months later all of the stainless alloy valves had failed ; the one of titanium looked so well that corrosion engineers say it will last more than ten years. Tests in other media were equally successful. In 15 per cent sodium hypochlorite at 195 deg. Fah., a stainless alloy valve had to be taken out of service at the end of three months. The titanium valve showed no evidence of corrosive attack or wear after six months, and it is estimated that it also will last a minimum of ten years. Another test exposed titanium to raw, brackish Delaware River water. Stainless steel is unusable because it pits rapidly in this service—2300 parts per million chloride at 285 deg. Fah. Bronze holds out for almost two years ; while titanium is so completely unaffected that corrosion engineers cannot even guess at its maximum life.

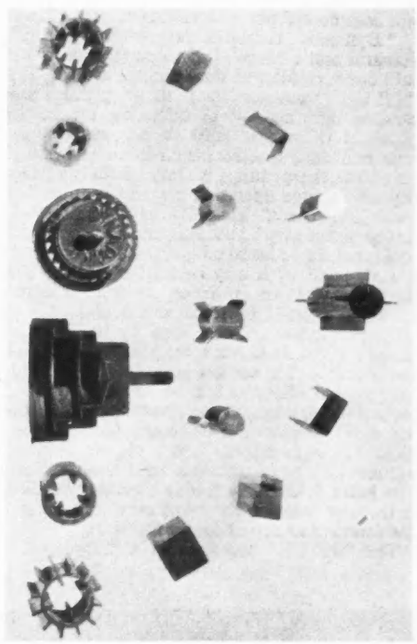


Fig. 7—Representative forged and extruded components and sections in the unmachined condition

General Dynamics Corporation

In the field of metal processing plant, the outstanding new development to be exhibited at this year's Metal Show was the "Dynapak" high-velocity machine tool designed and built by the Convair Division of the General Dynamics Corporation, San Diego, California. This machine applies a long-known but seldom employed law of pneumatics to the forging, forming, extruding, compacting, shearing and blanking of metals and other materials. The "Model 600," which is shown in Fig. 8, and was displayed for the first time at the exhibition, is capable of producing 40,000ft-lb of energy at velocities of more than 200ft per second. Its 12in piston stroke is so fast that the motion cannot be seen with the naked eye. While all of the phenomena associated with high-velocity metal-working are not yet fully understood, an important advance has been made with this technique. It is believed that many metals—including the

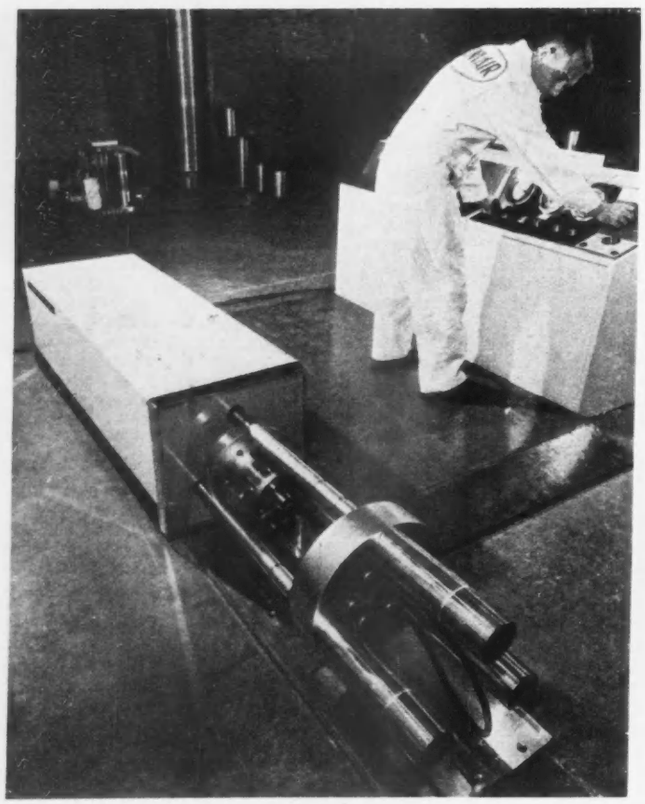
high-strength, high-temperature steels—exhibit hydrodynamic behaviour when worked at high velocities, with the application of high energy rates and corresponding pressures. It is hoped that " Dynapak " machines possibly will open up an entirely new metal working field in which high pressures are rapidly applied to move materials as fluids. Eventually, this technique may lead to parts that are " born to shape " with optimum design and require little or no additional machine shaping. Among the advantages derived from these new capabilities are a greater latitude in creating structural elements heretofore not producible. Many parts that have been difficult and costly to shape may now be produced in one inexpensive and simplified operation. The users may also benefit in many cases from the possibility of employing greatly simplified dies and tooling. For example, in the work done by Convair so far, heated dies have not been needed nor have lubricants been used.

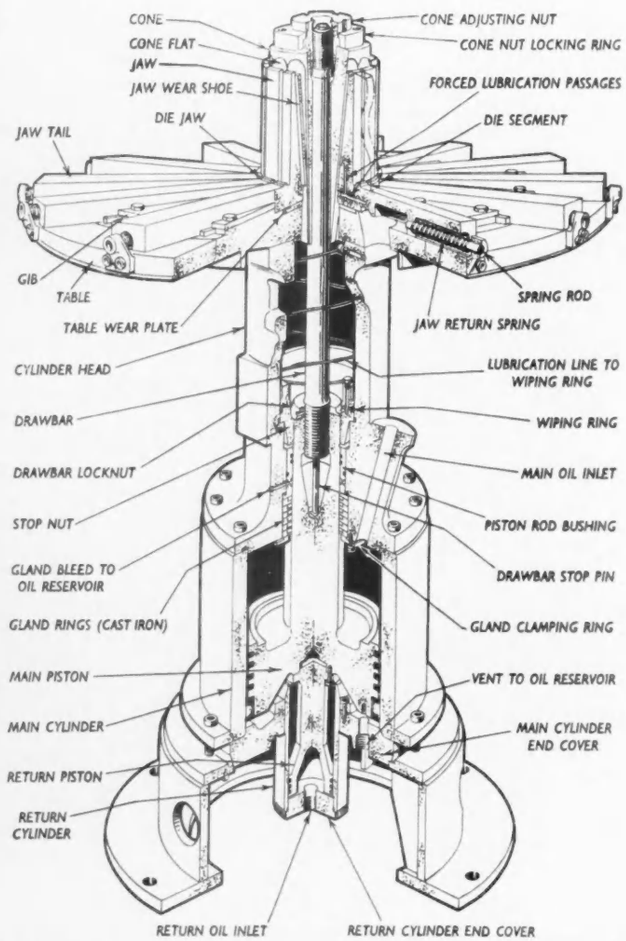
" Dynapak " combines the proven " HYGE " actuator and a Mark II dynamic reaction frame into one versatile and simple machine tool. The " HYGE " actuator is a self-triggering, gas-powered ram capable of delivering the energy potential of gas at 2000 lb per square inch instantaneously to a free piston-column assembly. Its output energy range is almost infinitely wide, depending upon operating pressures, piston diameter and stroke. Thus, this horizontally positioned piston may be used either as a free impact tool generating several million pounds of load on a work piece, or it may be used as a sustaining thrust device to produce several hundred thousand pounds of force at velocities up to 400ft per second. Such force by itself would have little value without some practical means of containing it. The successful applications of high energy rate deformation to metals such as molybdenum, titanium and precipitation hardening stainless steels are becoming widely recognised. How to employ forces and velocities of the required magnitude has been the problem. The Mark II dynamic reaction frame embodied in the new machine has provided a safe, simple and economical answer for the first time.

The " HYGE " actuator in a " Dynapak " machine is a cylinder separated into two chambers by an orifice plate. A piston in one chamber is connected to a thrust column which reacts directly against the specimen being worked. The other chamber is merely a reservoir for gas stored under high pressure. On the underface of the piston, and corresponding with the opening in the orifice plate, is a small seal ring. When the chamber containing the piston is pressurised to a low value, the piston is forced down against the orifice plate and the seal thus isolates the under-surface of the piston from the other chamber—except for the small piston face area inside the ring seal. Since pressure in the gas storage chamber can then react over only the small area inside the seal ring, the storage chamber must be pressurised to an extremely high value in order to obtain a balanced thrust condition on the piston. To illustrate, assume that the piston face has an area of 10 square inches and the orifice an area of 1 square inch. Suppose that the gas forcing the piston seal ring down upon the orifice plate is pressurised to 200 lb per square inch. To balance this, the gas in the storage chamber would need to be pressurised to 2000 lb per square inch. With the piston now in equilibrium, it is necessary to upset the pressure balance. This is accomplished by increasing the pressure in the high-pressure chamber by a slight amount—say, 1 lb per square inch—controlled by a solenoid-actuated trigger valve. The additional pressure starts the piston moving, but before it has moved even as much as a thousandth of an inch, the whole 2,001 lb per square inch of pressure in the storage chamber is applied against the entire 10 square inch face of the piston. Thus, the force on the piston is now ten times greater, causing 20,010 lb to push against the 200 lb in the other chamber. Obviously, this is an unequal struggle, involving a 19,810 lb pressure differential, and the piston is driven with almost explosive force, moving the full length of its stroke in a few milliseconds.

To return the piston to the seal position, a high-speed pump injects hydraulic fluid into the piston chamber, again forcing the piston down against the orifice plate and compressing the gas in the storage chamber to its former 2000 lb per square inch, except for a minute amount of nitrogen which must be exhausted after the piston is returned to the firing position. An indicator on the control console shows when the machine is cocked for firing. The cycle is repeated every thirty seconds with the 6in and 12in machines and every sixty seconds with the 18in machine. If this large amount of energy were hurled at a rigidly held die, no known material would withstand the force. Were it not for the dynamic reaction frame, the machine would shatter steel dies like china teacups. The dynamic frame provides a plate to react the load against. Since this plate on which the die is mounted has inertia, it can be of relatively light weight. But to accomplish the work, additional energy must be applied—and put into the plate. To take up this additional load, the reaction plate is tied by three heavy bars to a sturdy plate at the rear of the actuator. This plate, in turn, is connected to a shaft and piston housed within the high-pressure gas chamber. When the " Dynapak " fires, part of the load thus is transferred to the rear plate and piston assembly, which, in turn, is cushioned by the pressure in the storage chamber. In effect, the machine is its own shock-absorbing mechanism. To prevent oscillation of the dynamic reaction frame, hydraulic-pneumatic shock struts are installed on the lower tie bars. To decrease the stroke velocity without reducing the energy applied to the work, the machine is equipped with insert plates of varying thicknesses. The stroke length is unaffected, even when the maximum weight is added to the thrust column.

About five years ago, the firm began to experiment with high-velocity forming, using explosives as the driving force. Even with the newer hard-to-work super-alloys, parts were worked with better definition, to closer tolerances, and with





(Left) Fig. 8—Model 600 " Dynapak " high-velocity machine tool set-up for a 40,000ft-lb forging operation. (Right) Fig. 9—General arrangement of hydraulic expander head

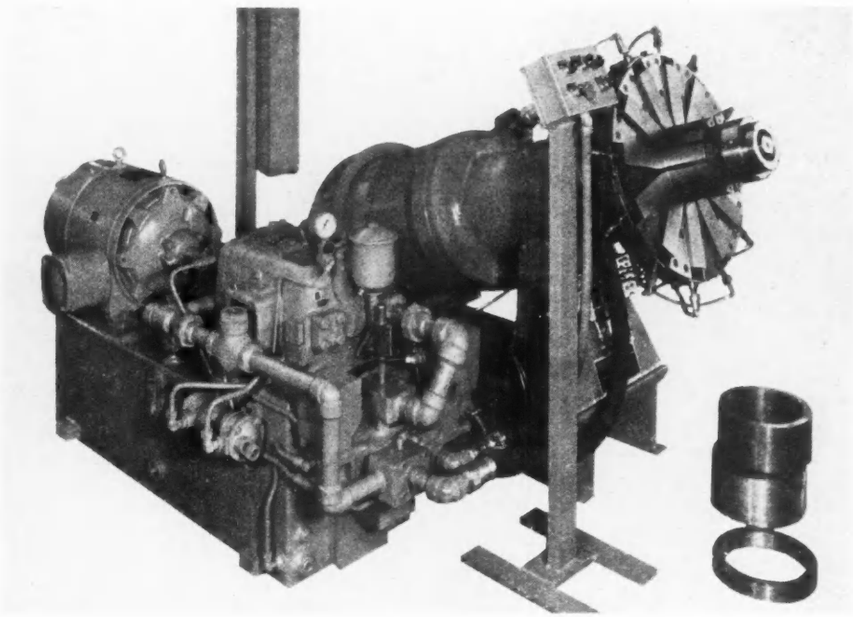


Fig. 10—Grotnes hydraulic expanding machine for circular sleeve production

little or no springback. But until Convair developed the pneumatically energised " HYGE " actuating mechanism as a rugged, but precise, instrument for aircraft and missile shock testing machines, there was no inherently safe and accurately controllable method of attaining the necessary high velocities. The " Dynapak " standard machines are being offered in three standard sizes, as indicated in the following table :—

	Model 600	Model 1200	Model 1800
Machine size, feet	2 by 9	3 by 12	4 by 14
Machine height, feet	2	3	4
Total floor space, square feet... ...	100	140	200
Cylinder bore, inches	6	12	18
Stroke, inches	12	12	12
Maximum velocity range (12in stroke), inches per second	2,500	2,500	2,500
Output energy (at 2,000 lb per square inch), feet-pounds	40,000	160,000	360,000
Bolster clearance, diameter, inches	10	20	36
Pump capacity, horsepower	10	50	75

Because of the extremely high pressures generated, " Dynapak " produces parts that cannot be made in any other way. For example, it extrudes parts with a web thickness of only one-hundredth of an inch, forges to zero draught angle, and produces smooth, close-tolerance surfaces that require little or no finish machining. The material being worked is forced into every crevice of a die by the high pressures used. Applications of the machines have ranged from forged gears to the compaction of ceramics, from rocket cases to automobile parts, from oilfield equipment to jet engine turbine blades. A number of representative forged and extruded parts are illustrated in Fig. 7. Applications for which the machine has been used or for which it is being evaluated include the extrusion of steel alloys, titanium and other materials, in which surface finish and tolerance are critical ; forging of hot or cold materials where maximum flow under a single blow is attained to produce parts with zero draught angles, minimum radii and finished surface ; forming of sheet materials where maximum deformation and part identity is required with materials normally regarded as difficult to form ; prefiring compaction of ceramic bodies where high density cannot be obtained with static loading ; compaction of powdered metals; and precision shearing and blanking with a one-piece die.

The " Dynapak " mechanisms are constructed of heat-treated chrome steel alloys, machined to close tolerances and hard-chrome-plated internally and externally to obtain long service life and resistance to corrosion. Compressed nitrogen is used as the energising gas because it is cheap and inert.

GROTNES MACHINE WORKS

The hydraulic expanding machine shown in Fig. 10 formed the major display of the Grotnes Machine Works, of Chicago, Illinois. In general, such expanding equipment is used to form or size parts having a continuous cross section (circular, square, oval, polygonal or even irregular) to predetermined shapes and dimensions. The expanding mechanism itself consists of jaws mounted in a slotted table and radially expanded by a tapered cone which is actuated by a drawbar and crankshaft. Practically any material can be expanded to a definite form or size consistent with the mechanical properties of the metal part to be worked. It is, however, required that a weld have such properties as to prevent rupture at this point during expansion. The sizing or forming operation of a part is accomplished by radially expanding the jaw members sufficiently to give the material a circumferential stretch great enough to pass the yield point of the material. This imparts a permanent set to the material and results in very precise control of the dimensions of the final product. Just about any shape can be produced by this method. It is possible to make square parts from cylindrical parts, or a cone from a cylinder. A given machine can accommodate a wide range of product sizes by a simple change of the die segments which are mounted on the faces of the jaws. When a product size cannot be accommodated by the jaws on the machine due to height or diameter limitations, it is possible to install new jaws or interchange complete head assemblies to accommodate a new part. Thus a single machine can be used for a wide range of sizes.

The expanding process has been found to be a most economical means of forming and sizing a wide range of parts. Expanding can be applied to sub-assemblies to eliminate distortions resulting from the assembly process. In addition, very heavy sections such as forged or flash-butt welded gear blanks, jet engine rings, hydraulic cylinders, and motor frames can be expanded to rough size eliminating considerable machining time and material waste. The principle utilised in cone expanders is that of the inclined plane or wedge. As shown in Fig. 9, the basic elements common to all expanders are a cone, a drawbar, jaws, a table and a power system. The cone (actually a poly-sided modified frustum of a pyramid) is attached to the drawbar, which is either hydraulically or mechanically actuated. As the cone is drawn down between the jaws they are forced radially outward at right angles to the direction of cone travel, moving in slots in the table. A part to be expanded is placed over the jaws—or over dies fastened to the jaws—and is formed or sized when the outward movement of the jaws is sufficient to stretch the metal beyond its yield point. After a part has been expanded, the cone is moved upward permitting the jaws to collapse and the part to be removed.

Dies or die segments may be clamped or bolted to the jaws or, in some cases, may be merely rested in place on the jaw tails. For many sizing and forming operations on relatively light gauge metal, $\frac{1}{2}$in thick die walls will ordinarily be sufficient. However, heavier walls may be required when handling parts of heavy gauge material or when sizing rings. Permanent dies are usually made of tool steel, Meehanite, cast iron or Kirksite. The dies are machined on the O.D. so they will form a true circle in the expanded position, and on the I.D. to match the O.D. of the jaws which are turned to form a true circle in the expanded position. The expanded diameter of the dies would be the same as the desired I.D. of the finished part. Most shapes can be produced with expanding or internal dies. There are cases, however, in which the required profiles are so complex or have such critical dimensional requirements that an outer die or set of dies must be used in conjunction with the inner dies. These may be simple rings, known as hold-back rings ; they may be solid, split and hinged, or made up of individual segments which are collapsible for loading and unloading purposes, and lever or cam operated either manually or by pneumatic or hydraulic cylinders. For some forming operations, such as a double offset, the outer die segments must also be driven inward which results in a shrinking operation. These outer dies may be simultaneously driven by toggles or a tapered ring, or may be individually actuated by independent hydraulic or pneumatic cylinders when the part shape so indicates. Parts are normally expanded at room temperatures ; however, expanders with heated dies and water-cooled jaws are available for forming and sizing parts in the heated state. In these cases, die temperatures of 500 deg. to 1100 deg. Fah. are used and cooling water is circulated through the jaws to prevent breakdown of the lubricant between the jaw cone and jaw table surfaces.

(To be concluded)

Road-Making Equipment

A NEW concrete batching equipment made by the C. S. Johnson Company, of Stockton, California, is provided with three aggregate bins of 100 cubic yards capacity and a cement hopper arranged for low-pressure aeration. These bins feed into three 38 cubic foot (3000 lb scale) batchers for aggregates and one 14 cubic foot (1000 lb scale) batcher for cement, giving a capacity adequate for a $1\frac{1}{2}$ cubic yard concrete mix. The batching cycle is stated to be only fifteen seconds.

Each aggregate scale on the machine is equipped with a moisture compensating beam and dial adjustment means for moisture content of material. The operator can introduce a mechanical mix sequence for any of twelve preset mixes by the setting of a single dial. Electric controls are used to actuate the air rams operating the batcher gates.

The Buffalo-Springfield Roller Company, of Springfield, Ohio, is now making a 3–5-ton tandem roller fitted with a torque converter drive that provides steplessly variable speeds from 0·5 to 5·3 m.p.h. in either direction. The machine has a large capacity hydraulic system that provides filtered, cooled oil through two circuits to the torque converter, transmission, and for the power steering unit. The roller can be provided with pneumatic-tyred towing wheels, which are raised and carried in recesses on the body during rolling.

HIGH ENERGY CHEMICALS.—An agreement was announced in the United States on Wednesday, December 10, between Dow Chemical Company and United States Borax Research Corporation, a wholly-owned subsidiary of United States Borax and Chemical Corporation (the operating company in the U.S.A. of Borax (Holdings), Ltd.), to engage in a joint venture to perfect an economic process for the manufacture of boron trichloride. Boron trichloride is a highly reactive intermediate from which many of the newer boron compounds can be made. Dow and U.S. Borax have both been engaged for some time independently on research in this field, which has become of great importance with the developing need for high-energy fuels for aircraft and the later stages of rockets.

Personal and Business

Appointments

AIR CONTROL INSTALLATIONS, Ltd., announces that Mr. R. Fulton has been appointed marine manager.

MR. F. L. Gibson has been appointed sales manager for the home market of Wolf Electric Tools, Ltd.

MR. A. DOUGLAS SHARP has been appointed a director of Brightside Heating and Engineering Company, Ltd.

THE SCIENTIFIC FILM ASSOCIATION has announced that Mr. Edmund J. Cooper has been appointed general secretary.

ENGLISH STEEL CORPORATION, Ltd., announces that Mr. W. E. A. Redfearn has been appointed a director with effect from January 1.

MR. R. H. MARDELL has been appointed London area sales manager for General Refractories, Ltd., in succession to Mr. T. S. Aikman who has recently retired.

MR. L. M. ROBERTSON has been appointed engineer-in-charge of the British Broadcasting Corporation's Orkney television and v.h.f. sound broadcasting station.

CAMMELL LAIRD AND CO. (SHIPBUILDERS AND ENGINEERS), Ltd., announces that Mr. G. F. Rogerson, the ship technical manager, has been appointed a director.

MR. W. FORBES RITCHIE, until recently chief engineer of the Consolidated Pneumatic Tool Company, Ltd., has been appointed manager of factory operations.

DR. A. J. KESTERTON, superintendent of steel production of the steel division, Steel Company of Wales, Ltd., will be taking up the appointment of managing director of Davy British Oxygen, Ltd., early in 1959.

HANDLEY PAGE, Ltd., announces that Mr. K. C. Pratt, A.M.I.Mech.E., has been appointed chief engineer, in succession to Mr. W. H. Macrostie who recently retired.

ASSOCIATED ELECTRICAL INDUSTRIES announces the appointment of Mr. S. C. Leslie as consultant on information policy, both external and internal. The appointment will take effect in February.

THE IRON AND STEEL INSTITUTE has announced that Mr. William Barr has been nominated by the council for election as president of the institute for the 1959–60 session. He will take office at the autumn general meeting on May 6, 1959.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces the following appointments: Mr. B. Dawkins, A.M.I.E.E., assistant manager, education department, and Mr. P. A. J. Manley, S.I.Mech.E., assistant superintendent, large turbine department, Trafford Park A.E.I. turbine generator division.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY has appointed Mr. L. Grainger as head of the metallurgy division in the Authority's Research Group at Harwell. He is to succeed Dr. H. M. Finniston, who is being released by agreement to take up an appointment with the Nuclear Power Plant Company.

SAUNDERS-ROE, Ltd., announces that Mr. W. Browning has been appointed Deputy Chairman of Saunders-Roe (Anglesey), Ltd., Saro Laminated Wood Products, Ltd., and Saro Structures, Ltd., and that Mr. H. W. D. Winkworth has been appointed to the board of Saunders-Roe, Ltd., as works director.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION has announced that Sir Wilfred Neden and Mr. Frank Taylor have been appointed additional members of the board of B.O.A.C. Sir Francis Brake will relinquish his appointment on the main board of B.O.A.C. at the end of the year in order to be able to concentrate on the affairs of B.O.A.C. Associated Companies, Ltd.

Business Announcements

OZALID COMPANY, Ltd., announces that its address is now Langston Road, Loughton, Essex (telephone Loughton 5544).

MR. P. S. FOWLER, M.I.Mech.E., managing director of W. Sisson and Co., Ltd., is to retire at the end of December, after completing sixty years with the company.

COCKBURNS, Ltd., Cardonald, Glasgow, C.2, has been granted a licence by W. S. Rockwell Company, Fairfield, Connecticut, U.S.A., to manufacture its "Wafer" butterfly valves.

THE OWEN ORGANISATION announces the formation of a new company, Mahindra Owen Private, Ltd., Gateway Building, Apollo Bunder, Bombay, 1 (telephone, 219131), to serve its interests in India. The company will be engaged in the production and sale of motor vehicle components, including heavy and general purpose trailers and chassis components.

G. AND J. WEIR, Ltd., Cathcart, Glasgow, S.4, states that Mr. Ian G. Craig, head of its contracts division, and a member of the Cathcart executive board, has resigned.

BUREAU VERITAS announces that its board of directors has approved an agreement between the Polish Government and the Society which allows Bureau Veritas to resume its activities in Poland.

DURHAM RAW MATERIALS, Ltd., announces that its Manchester office has moved to Canada House, 3, Chepstow Street, Oxford Street, Manchester, 1 (telephone Central 2683). Mr. Dennis Dunton has been appointed manager of this office.

TURNER AND NEWALL, Ltd., has announced that negotiations have been completed for the acquisition by its Rhodesian mining subsidiary, Rhodesian and General Asbestos Corporation (Pvt.), Ltd., of the entire issued share capital of Rhodesian Asbestos, Ltd.

AUTOMOTIVE PRODUCTS ASSOCIATED, Ltd., Leamington Spa, has announced the formation of a new company, to be known as Lockheed Precision Products, Ltd. The company will manufacture and sell aircraft and industrial hydraulic equipment and Lockheed-Avery hoses and couplings.

POWELL DUFFRYN, Ltd., announces that Mr. K. A. Hogan, a director of the company, of Stephenson Clarke, Ltd., and of other companies in the Powell Duffryn Group, will relinquish these directorships at the end of March, 1959, in order to take up another appointment. His advice will continue to be available to the group.

GOODYEAR TYRE AND RUBBER COMPANY (GREAT BRITAIN), Ltd., states that a new sales division has been created, to be termed general products division, which will incorporate industrial rubber products, shoe products, films and adhesives and chemical products. Mr. K. H. Johnston has been appointed sales manager of the new division.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that with effect from December 15, the address of its Norwich office will be 56, Pitt Street, Norwich (telephone Norwich 21526); and with effect from December 22, the address of its Cardiff office will be Station Terrace, Queen Street, Cardiff (telephone Cardiff 24716). The Worcester branch office has been allocated another telephone number, Worcester 6074. This is in addition to its present number, 2070.

SCAFFOLDING (GREAT BRITAIN), Ltd., has opened three new depots: Gosbeck Road, Colchester (telephone Colchester 77142), manager, Mr. Harry J. James; Ware Street, Bearsted, Maidstone (telephone Maidstone 87833), manager, Mr. Arthur Taylor; and Bessemer Road, Norwich (telephone Norwich 27871), manager, Mr. Rupert Lorimer. Mr. Norman Barton has been appointed manager of the Preston depot, Victoria Street, Preston, (telephone Preston 57204), in succession to Mr. George Casey who has resumed the managership of the Reading depot, Gasworks Lane, Twyford (telephone Twyford 211). Mr. D. S. Cooper has been appointed manager of the Edinburgh depot, West Saville Terrace, Newington, Edinburgh (telephone Edinburgh 43191).

STEWARTS AND LLOYDS, Ltd., has announced that Mr. J. R. Menzies-Wilson and Sir Frederick Scopes are to retire as managing directors on December 31, 1958, but remain directors of the company. Mr. J. R. Menzies-Wilson also remains chairman of Stewarts and Lloyds of South Africa, Ltd. and Stewarts and Lloyds Minerals, Ltd., and Sir Frederick Scopes remains chairman of the Stanton Ironworks Company, Ltd. Mr. L. M. T. Castle, director and secretary, has resigned from his appointment as secretary and has been appointed managing director, finance and general administration—his resignation and appointment to take effect from January 1, 1959. Mr. R. Otley has been appointed secretary of the company as from January 1, 1959. Mr. G. H. T. Macleod, deputy secretary, has resigned that appointment and has been appointed an assistant secretary, and controller general administration—his resignation and appointment to take effect from January 1, 1959. Mr. T. W. Tomlinson has been appointed an assistant secretary as from January 1, 1959.

Miscellanea

SUBMARINE OIL PIPELINE.—It is announced that construction of the 23 mile submarine pipe line, linking Ganaveh on the mainland to Kharg Island in the Persian Gulf, together with the associated storage tanks, will be supervised by Welding Supervision, Ltd.

GLAZING LACQUER.—We are informed that Swale Chemicals, Ltd., has developed an acetate based paper glazing lacquer, "Flexoglaze," which has a glazing temperature of 70 deg. to 80 deg. Cent. at low working pressure. It has good flow properties and does not discolour or deteriorate on ageing.

SCHOOL OF WELDING TECHNOLOGY.—We are informed by the Institute of Welding, 57, Princes Gate, London, S.W.7, that some places are still available for courses at the School of Welding Technology, in January and February next. One of these courses, on training, testing and approval of welders, is to be held from January 12 to January 16, and the other, on brazing technology and design, will be held from February 9 to 13, 1959.

A CAREER IN WATER ENGINEERING.—The Institution of Water Engineers has published a brochure which aims at recruiting young men into the water engineering profession. The duties of an engineer engaged in this work and the benefits which he bestows on the community are set out in an attractive manner. The professional qualifications needed are given in detail, and figures are given for the salary which a water engineer may be expected to earn at various stages in his career. Since corporate membership of one of the three major institutions—civil, mechanical or electrical—is stipulated as a qualifying condition for corporate membership of the Institution of Water Engineers, the requirements of the three major Institutions for corporate membership are set out, side by side, in tabular form.

WELDING IN RUSSIA.—We are informed that the British Welding Research Association is undertaking the regular translation from the Russian of complete issues of *Avtomaticheskaya Svarka* (Automatic Welding). The January, 1959, number of that journal is expected to arrive in Britain in March, and to be distributed in translation to subscribers in May or late April. The Association states that *Avtomaticheskaya Svarka* is the only monthly journal in any language with the title "Automatic Welding," though it pointed out that the title is not absolutely descriptive except in so far as manual techniques are not emphasised. Equipment and methods of welding are dealt with, as well as metallurgy, the strength of welded work generally, and fatigue testing. It is the organ of the Arc Welding Institute of the Order of the Red Banner of Labour at Kiev in the Ukraine.

MOUNTING PADS FOR MACHINERY.—A new medium for installing machinery which provides efficient fixing without the need for bolting down or grouting has been introduced by James Walker and Co., Ltd., Woking, Surrey. The medium, known as "Tico," is used as a special bonded cellular material which is resistant to oils, spirits and water, and it is supplied in the form of machinery mounting pads. These pads are stated to reduce considerably the transmission of vibration between machine and floor, as they form an effective cushion. The pads are supplied in seven standard thicknesses from ¼in to 3in and twenty-one standard widths up to 48in. An adhesive is usually used with the pads but is not necessary in all cases, and it is recommended that the weight loading should not exceed 50 lb per square inch. The material is also made in shimming thicknesses for levelling up machinery on uneven floors. Sizes ranging from 0·020in to ¼in thick are available.

DIESEL-ELECTRIC PERMANENT WAY CRANE.—A new diesel-electric railway permanent way travelling crane, for track work on lines electrified on the overhead system, has been ordered by the British Transport Commission for the London Midland Region of British Railways. This crane has been designed by Taylor and Hubbard, Ltd., of Leicester, in collaboration with British Railways, as a prototype for track work on electrified lines where cranes with normal jibs cannot be used effectively owing to the restrictions imposed by the overhead conductor wire and its supports. The crane is equipped with a cranked jib which has a telescopic upper section that can be extended or retracted under load, and will be capable of lifting 6½ tons at 18ft radius, with the jib raised, diminishing to 1 ton at 40ft radius, when the jib is fully extended horizontally. With the jib in the horizontal position, the crane will be able to work under overhead equipment. The crane will be able to travel at up to 5 m.p.h. under its own power, and will be equipped for speeds of up to 60 m.p.h. when being hauled in train formation.

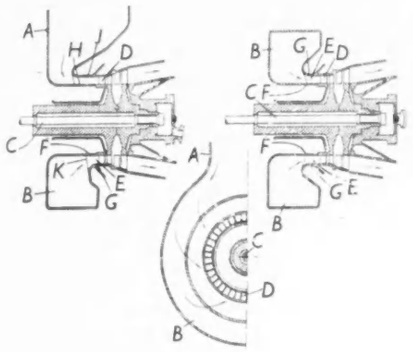
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

GAS TURBINES AND COMPRESSORS

805,003. June 25, 1954.—INLET DUCT ARRANGEMENTS, W. H. Allen Sons and Co., Ltd., Queens Engineering Works, Bedford, and Francis Cyril Perrott and John Thomas Bosher Oxford, both of the company's address.

The invention relates to inlet duct arrangements for gas turbines or compressors of the axial flow type or compressors of the centrifugal type, of the kind wherein the gas or air enters the turbine or compressor casing laterally at one or more sides. The invention as applied by way of example to a gas turbine of the axial flow type is illustrated in the drawing. The combustion chamber of the turbine,



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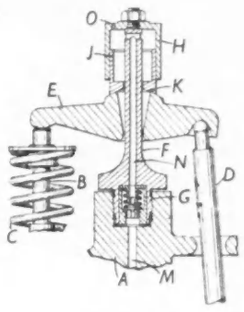
partly indicated at *A*, is connected with a circumferential passage or annular chamber *B* surrounding the turbine shaft *C*, the connection with the combustion chamber being on one side of passage *B* so that the gases enter approximately radially as shown by the arrow and travel circumferentially round both sides thereof. The approximate flow round one side of the circumferential passage is indicated by the arrows in the lower view. The passage *B* communicates with the annular inlet to the turbine blading *D* by an annular approach passage indicated generally at *E*. After a rounded inlet, the radial dimensions of this annulus are approximately uniform as defined by the walls *F* and *G* in the right-hand view, while the axial length of the passage is considerably greater at a point adjacent the inlet from the combustion chamber than at a point in the circumferential passage diametrically opposite the said inlet point. This is shown in the left-hand view where the wall portions *H* and *F* defining the annular passage are considerably longer than the wall portions *F* and *G* diametrically opposite. The length of the approach passage is progressively varied between the diametrically opposite points so that the plane of entry to the passage, indicated at *K* in the left-hand view, is suitably inclined to the axis of the turbine shaft *C*.

The radial depth of the annular approach passage is sufficiently small to ensure that the velocity of the gas in it is substantially greater than the velocity in the circumferential passage *B*. Consequently, the static pressure of the gas falls upon entry into the approach passage, and by reason of the inclination of the plane *K*, lines of constant static pressure are inclined in directions roughly parallel to the plane of entry. This condition tends to produce some acceleration in a direction towards the region of the lateral inlet, and thereby tends to correct the occurrence of whirl in the annular approach passage, which otherwise would produce disadvantages. The degree of correction of whirl is governed by the angle by which the lines of constant static pressure are inclined to a transverse plane, and in this case a plane inclined entry to the approach passage affords the maximum degree of correction where whirl would otherwise be greatest. Modified designs are also shown in the specification.—*November* 26, 1958.

INTERNAL COMBUSTION ENGINES

805,109. April 26, 1956.—VALVE-ACTUATING MECHANISMS, Rolls-Royce, Ltd., Nightingale Road, Derby. (*Inventor: Shadwell Harry Grylls.*)

Referring to the drawing there is shown at *A* the cylinder head of a reciprocating internal combustion engine having a poppet valve *B* loaded by a spring *C* and actuated by a push-rod *D* through a rocker arm *E*. The rocker arm is hydraulically supported as follows: A pedestal *F* has at its lower end a threaded boss *G* in a bore in a boss on the cylinder head. The pedestal has a cylindrical stem which extends up through a hole in the rocker arm and carries at its upper end an inverted cup *H* which provides the cylinder of a piston. The piston *J* slides within the cup *H* and has in its crown a bore through which the pedestal stem projects. The outer surface *K* of the



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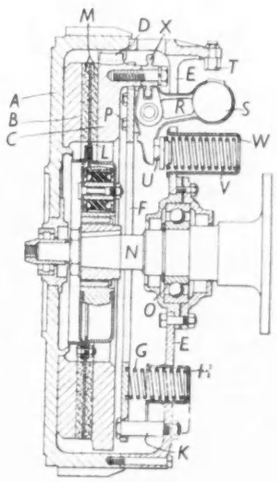
crown is formed as a part-spherical recess and this surface provides the fulcrum for the rocker arm *E*. Oil under pressure bled from the engine lubricating system is fed to the cylinder *H* through a duct *M* in the cylinder head *A*, past a non-return valve, and through a duct *N* opening into the cylinder. The cylinder has a fine bleed hole *O* which releases air from the system. A modified design is also shown in the specification.—*November* 26, 1958.

POWER TRANSMISSION

804,759. January 18, 1956.—CENTRIFUGAL CLUTCHES, Leyland Motors, Ltd., Suffolk House, Laurence Pountney Hill, London, E.C.4. (*Inventor: Thomas Crook.*)

When a centrifugal clutch is employed with an internal combustion engine, it is undesirable that the clutch should engage immediately the engine starts; the taking up of the gap between the clutch parts should be deferred until a good idling speed has been



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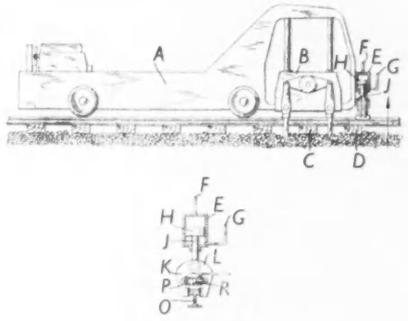
exceeded. To this end the present invention is concerned with an improved construction of an automatic clutch. From the drawing it will be seen that the driving member of the friction clutch is the flywheel *A* provided with a friction surface *B*, together with a pressure plate *C* having a dog clutch engagement *D* with the flywheel. The friction clutch and much of its operating mechanism are enclosed between the flywheel and a cover plate *E* bolted to the rim of the flywheel. Between the pressure plate *C* and the cover plate *E* is a pivot plate *F*, urged towards the presser plate by springs *G* lodged in sockets *H* received in holes in the cover plate. Bolts *K* limit movement of the pivot plate from the cover plate, and permit of the springs *G* being prestressed to the desired extent. Between the flywheel and the cover plate is a driven plate *L* with frictional surfaces *M* to engage them, and it is attached, preferably resiliently, to the driven shaft *N*, which turns in a bearing *O* in the cover plate *E*. To the pivot plate *F* are secured by bolts *P* bearings for a number of three-armed levers *R*. One arm of each lever projects through an opening in the cover plate and has an enlarged and weighted end *S*; the outward swing of this arm is limited by its abutting upon adjustable stops *T* carried by the cover plate; these can, however, be dispensed with. Another arm of each lever bears through a ball *U* upon a spring *V* contained in a sheet metal socket *W* lodged in a hole in the cover plate and retained by its outwardly flared rim. The third arm of each lever may be forked to embrace the rim of a pressure pad *X* attached to the presser plate. The pad is preferably adjustable to take up wear on the clutch friction surfaces; in the construction shown adjustment is effected by turning the pad. While the engine is stationary the springs *V*, resisting rocking of the levers *R* under centrifugal force, are unstressed; the springs *G* which support the pivot plate *F* against axial thrust are prestressed. As the engine speeds up the levers *R* turn, the masses *S* moving outward, and the springs *V* begin to be compressed, and at a speed a little above idling speed the clutch begins to be engaged. At engine full torque speed the springs *V* are more highly loaded, the clutch is fully and firmly engaged and there is additional load on the springs *G*. If the engine attains the speed determined by its governor, the torque being below full engine torque, the springs *V* and *G* are still further loaded, and the levers *R* rest upon their stops *T*. Springs of the same size may be used for resisting rotation of the levers and for locating the presser plate, the conditions of their mounting imposing suitably different prestressing.—*November* 19, 1958.

RAILWAY ENGINEERING

804,719. October 22, 1956.—APPARATUS FOR USE IN THE PACKING OF RAIL TRACKS, Franz Plasser and Josef Theurer, both of 16, Marokkanergasse, Vienna 111, Austria.

According to the invention a mobile rail track packing machine has a packing tool carrier, and, on the front end a track lifting mechanism which is operated to raise the track to a predetermined height before the commencement of the packing operation.



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Referring to the drawing, the machine *A* is provided with a packing tool carrier *B*, which is vertically adjustable and projects forward over the sector of track to be packed, and is slidably mounted on vertical columns. At the front end of the machine (looking in the direction of travel) is a track lifting mechanism constructed according to the invention (see the lower view). When the packing tool carrier *B* is situated above a sleeper *C*, then the track lifting mechanism is already above the next sleeper *D*. Nevertheless, a lifting action in the region of the sleeper *D* also acts directly on the sleeper *C* which is to be under-packed, but not on the already packed sleepers upon which the weight of the machine bears through its wheels. The track lifting mechanism comprises a double-acting lifting cylinder *E* having a discharge pipe *F* and a feed pipe *G* for the fluid pressure medium, which is preferably hydraulic, and a piston *H* to the piston-rod *J*, of which the gripping device is fixed. The gripping device fixed to the lower end of the piston-rod *J* comprises two jaws *K* and *L*, connected together, in the manner of a pair of tongs *M* and which are provided at their lower ends, where they engage on both sides of the rail head, with a friction facing. The rail is held fast by these two jaws *K* and *L* that it does not suffer from any considerable vibration. As a result, the detrimental effects which such vibrations could have on the already packed sector of track are avoided. In order to make it possible to obtain a clamping action by the jaws *K* and *L* the jaw *K* has a cylinder *P* articulated to it, whilst a piston *R*, which is associated with the cylinder *P*, is articulated to the other jaw *L*. This clamping mechanism *P* and *R* is operated hydraulically.—*November* 19, 1958.

Launches and Trial Trips

BELGULF GLORY, oil tanker ; built by the Furness Shipbuilding Company, Ltd., for Gulf Oil (Belgium) S.A. ; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, draught 30ft 6in, deadweight 18,000 tons ; twenty-seven cargo oil tanks, one cargo pump room, three 700 tons per hour turbine-driven centrifugal pumps, three 150 tons per hour vertical duplex stripping pumps ; two 400kW turbo-generators, one 100kW diesel-driven generator ; trial speed 15¼ knots ; one set of Richardsons Westgarth double reduction geared steam turbines, 7300 service s.h.p. at 100 propeller r.p.m., 8200 maximum s.h.p. at 104 propeller r.p.m., two Foster-Wheeler "D" watertube boilers supply steam at 450 lb per square inch and 750 deg. Fah. Trial, September 9.

NEW MEXICO, oil tanker ; built at Belfast by Harland and Wolff, Ltd., for Texaco; length between perpendiculars 600ft, breadth moulded 84ft, depth moulded 44ft, deadweight 27,750 tons on 33ft draught ; thirty oil cargo tanks, one cargo pump room ; two 500kW turbine-driven 400V 60 c/s alternators, one 75kW diesel-driven emergency alternator ; one set of compound, double reduction geared turbines, 12,500 service s.h.p. at 100 propeller r.p.m., supplied with steam at 600 lb per square inch and 840 deg. Fah. by two Combustion Engineering Inc. watertube boilers. Trial, September 15.

SUGAR REFINER, bulk carrier ; built by Hall, Russell and Co., Ltd., for Silvertown Services Shipping, Ltd. ; length between perpendiculars 370ft, breadth moulded 53ft, depth moulded 28ft, deadweight 6550 tons on 22ft 3in draught ; four holds, eight 6-ton derricks, electric winches, three 125kW diesel-driven generators ; Werkspoor-Sulzer, single-acting, two-stroke diesel engine, six cylinders 600mm diameter by 1040mm stroke, 3000 b.h.p. at 150 r.p.m. Launch, September 16.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, Dec. 19.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "Design and Construction of Precision Toroidal Potentiometers for Data Transmission," H. J. Arnott, 7 p.m.
Wed., Jan. 14.—SOUTH WALES SECTION : College of Advanced Technology, Cardiff, "Computer Control of Machine Tools," H. Ogden, 6.30 p.m. ★ NORTH EASTERN SECTION : Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, "The Design and Construction of an Electronic Digital Computer," R. W. Walker, 6 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., Jan. 7.—LONDON BRANCH : St. Ermins Hotel, Westminster, London, S.W.1, "Case Histories of Fuel Savings," H. A. Haines, 10.30 a.m.; "Advances in Process Control," V. O. E. Bryant, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Thurs., Jan. 8.—MANCHESTER CENTRE : North Western Electricity Board, Town Hall Extension, Manchester, 2, "Random Review of 1958," A. G. Penny, 6 p.m. ★ NOTTINGHAM CENTRE : Electricity Service Centre, Nottingham, "The Artistic Use of Lighting in Multi-Camera Television Technique," H. E. H. Mayhew, 6 p.m.
Mon., Jan. 12.—LEEDS CENTRE : British Lighting Council, 24, Aire Street, Leeds, 1, Forum on "Home Lighting," 6.15 p.m. ★ SHEFFIELD CENTRE : Department of Mining, University of Sheffield, Mappin Street, Sheffield, "Mine Lighting Problems," A. Roberts, W. J. Wellwood Ferguson, A. G. Neill and B. N. Clarkson, 6.30 p.m.
Tues., Jan. 13.—LONDON CENTRE : Federation of British Industries, 21, Tothill Street, London, S.W.1, "Designed Appearance Lighting of Gloucester Cathedral," J. M. Waldram, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Jan. 6.—EDINBURGH SECTION : 25, Charlotte Square, Edinburgh, "Selection of Electric Motors for Industrial Purposes," H. E. Russle, 7 p.m. ★ LONDON SECTION : Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Trends in Hospital Engineering Services," G. A. Rooley, and L. G. Hadley, 7 p.m. ★ PETERBOROUGH SECTION : White Lion Hotel, Church Street, Peterborough, "Nuclear Reactor Fundamentals," R. R. Gunton, 7.30 p.m.
Wed., Jan. 7.—LEICESTER SECTION : Bell Hotel, Leicester, "Application of Thermostatic Controls," J. S. Smith, 7 p.m. ★ SOUTHERN SECTION : Polygon Hotel, Southampton, "The Limited Liability Company," S. J. Clark, 7.30 p.m.
Thurs., Jan. 8.—GLASGOW SECTION : Scottish Building Centre, 425-427, Sauchiehall Street, Glasgow, "Safety in the Uses of Industrial Gases and Equipment," T. Reeks, 7.15 p.m. ★ NORTH EAST SECTION : Roadway House, Oxford Street, Newcastle upon Tyne, "Motive Power for Railway Purposes—A Comparison of Steam, Diesel and Electric Locomotives," J. E. Davidson, 7 p.m.
Tues., Jan. 13.—MANCHESTER SECTION : Engineers' Club, Albert Square, Manchester, "Industrial Law and the Plant Engineer," C. N. Glidewell, 7.15 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Thurs., Jan. 8.—BEDS AND HERTS SECTION : K. and L. Steelfounders and Engineers, Ltd., Letchworth, "A Modern Foundry for the Manufacture of Small Steel Castings," T. A. Marsden, 7.30 p.m.

INSTITUTE OF FUEL

Thurs., Jan. 8.—SOUTH WALES SECTION : South Wales Institute of Engineers, Park Place, Cardiff, "Collection, Transmission and Utilization of Methane from the Afan Valley," S. L. Wright, W. T. Hird and G. Thomas, 6 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Jan. 5.—MERSEYSIDE AND NORTH WESTERN SECTION : Liverpool Engineering Society, The Temple, Dale Street, Liverpool, Discussion on "Marine Engineering Problems," 6 p.m.
Wed., Jan. 7.—WEST MIDLANDS SECTION : Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Nuclear Steam Propulsion for Merchant Ships," W. R. Wootton, 7 p.m.

INSTITUTE OF NAVIGATION

To-day, Dec. 19.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Admiralty Chart," G. S. Ritchie and A. J. R. Tyrell, 5.15 p.m.

INSTITUTE OF PETROLEUM

Wed., Jan. 7.—LONDON BRANCH : 61, New Cavendish Street, London, W.1, "Petroleum-Based Launching Lubricants," G. H. Clark and D. A. Davidson, 5.30 p.m.

INSTITUTE OF REFRIGERATION

Thurs., Jan. 8.—Institute of Marine Engineers, Memorial Building, 76, Mark Lane, London, E.C.3, "An Economic Evaluation of Large Ammonia Absorption Refrigerating Machines," G. G. Haselden, 5.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., Jan. 12.—NORTHERN CENTRE : North Eastern Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, "Drainage of Agricultural Land," G. H. Theobald, 6.45 p.m.
Tues., Jan. 13.—LONDON BRANCH : 6, Buckingham Gate, London, S.W.1, "Ground Adhesion Problems of Wheeled Agricultural Tractors," A. Senkowski, 2.15 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Jan. 6.—LONDON BRANCH : Geological Society, Burlington House, London, W.1, "Feed Water and Boiler Water Standards in the Central Electricity Generating Board," R. Ll. Rees and F. J. R. Taylor ; and "The Treatment of Water for an Industrial High Pressure Boiler Plant," J. Arthurs, J. A. Robins and T. B. Whitefoot, 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Sat., Dec. 20.—NORTH WESTERN ASSOCIATION : Queen Hotel, Chester, Conversazione, 6.30 p.m.
Mon., Dec. 29.—Great George Street, Westminster, London, S.W.1, Christmas Lecture for Boys and Girls, "Peculiar Railways," L. T. C. Rolt, 3 p.m.
Tues., Dec. 30.—Great George Street, Westminster, London, S.W.1, Christmas Lecture for Boys and Girls, "86 Days Round the World," A. McDonald, 3 p.m.
Tues., Jan. 6.—Great George Street, Westminster, London, S.W.1, "Tehran Water Supply—Water Treatment and Chemical Manufacturing," G. A. Meykadeh, R. L. Fitt and T. J. Boddington, 5.30 p.m.
Thurs., Jan. 8.—MIDLANDS ASSOCIATION : James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Recent Advances in the Testing, Control and Evaluation of Concrete," R. Goodacre, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Tues., Dec. 23.—S.W. SUB-CENTRE : St. Luke's College, Exeter, Christmas Holiday Lecture for Schoolchildren, "Electric Motors and the Electrical Industry," G. H. Rawcliffe, 2.30 p.m.
Mon., Jan. 5.—RADIO AND TELECOMMUNICATION SECTION : Savoy Place, London, W.C.2, "The Application of Transistors to Line Communication Equipment," H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead, 5.30 p.m. ★ SOUTH MIDLAND CENTRE : College of Technology, Gosta Green, Birmingham, "The Design of the 330kV Transmission System for Rhodesia," F. C. Winfield, T. W. Wilcox and G. Lyon, 6 p.m.
Tues., Jan. 6.—MEASUREMENT AND UTILIZATION SECTIONS : Savoy Place, London, W.C.2, "Silicone Electrical Insulation," J. H. Davis, 5.30 p.m. ★ NORTH MIDLAND CENTRE : C.E.G.B. Offices, Leeds, "Standardization of Control Facilities for the British Grid : Communications, Indications and Telemetering," P. F. Gunning ; "The Development of Communication, Indication, and Telemetering Equipment for the British Grid," G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning, 6.30 p.m. ★ NORTH WESTERN CENTRE : Engineers' Club, 17, Albert Square, Manchester, "Design of Electro-Mechanical Auxiliaries Directly Associated with Power-Producing Reactors," A. E. Harwood, P. Scott and B. H. Stonehouse, 6.15 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, "Electrical Insallation at Calder Hall Nuclear Power Station," N. J. Mackay and E. Hardwick, 7 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE : Royal College of Science and Technology, George Street, Glasgow, "A New Cathode-Ray Tube for Monochrome and Colour Television," D. Gabor, P. R. Stuart and P. G. Kalman, 7 p.m.
Wed., Jan. 7.—TEES-SIDE SUB-CENTRE : Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "ZETA—The Engineering Aspects of the British Controlled Thermonuclear Reaction Experiments," R. Carruthers, 6.30 p.m. ★ SOUTH-EAST SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, "A New Cathode-Ray Tube for Monochrome and Colour Television," D. Gabor, P. R. Stuart and P. G. Kalman, 7 p.m. ★ SOUTHERN CENTRE : C.E.G.B. Offices, 111, High Street, Portsmouth, "Ultrasonics in Industry," C. F. Brockelsby, 6.30 p.m.
Thurs., Jan. 8.—ORDINARY MEETING : Savoy Place, London, W.C.2, First Hunter Memorial Lecture, L. G. Brazier, 5.30 p.m. ★ NORTH SCOTLAND SUB-CENTRE : Electrical Engineering Department, Queen's College, Dundee, "Standardization of Control Facilities for the British Grid : Communications, Indications and Telemetering," P. F. Gunning, and "The Development of Communication, Indication and Telemetering Equipment for the British Grid," G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning, 7 p.m. ★ WEST WALES (SWANSEA) SUB-CENTRE : Conference Room, S.W.E.B. Showrooms, The Kingsway, Swansea, "Electrical Engineering in the Mining Industry," J. P. Aldron and M. R. Lloyd, 6 p.m.
Fri., Jan. 9.—NORTH SCOTLAND SUB-CENTRE : Robert Gordon's Technical College, Aberdeen, "Standardization of Control Facilities for the British Grid : Communications, Indications and Telemetering," P. F. Gunning, and "The Development of Communication, Indication and Telemetering Equipment for the British Grid," G. A. Burns, F. Fletcher, C. H. Chambers and P. F. Gunning, 7.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Jan. 12.—NORTH EAST BRANCH : Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, 1, "Design in Relation to the Production of Castings," G. Elston, 7.15 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Wed., Jan. 7.—EAST ANGLIA BRANCH : Assembly House, Theatre Street, Norwich, Film Show, 6.45 p.m.
Thurs., Jan. 8.—LONDON BRANCH : Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Urban Motorways," G. W. Kirkland, 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Dec. 19.—JAMES CLAYTON LECTURE : 1, Birdcage Walk, Westminster, London, S.W.1, "The Hydraulic Turbine in Evolution," P. Danel, 6 p.m.
Mon., Jan. 5.—NORTH EASTERN BRANCH : Stephenson Building, Claremont Road, Newcastle upon Tyne, "Some of the Highlights of the Geneva Conference on Atomic Energy," B. Wood, 6.15 p.m.
Tues., Jan. 6.—INTERNAL COMBUSTION ENGINE GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on the "Influence of Infinitely Variable Torque Conversion on Engine Design," 6 p.m. ★ NORTH EASTERN BRANCH : Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Mechanical Marshalling of Railway Wagons in Works Sidings," G. W. Grossmith, 6.15 p.m. ★ COVENTRY A.D. CENTRE : Grosvenor Room, Leofric Hotel, Coventry, Three Papers on "Internal Combustion Engine Dynamics," R. Clink, C. A. Beard, and D. R. Braund, 7.15 p.m.
Wed., Jan. 7.—LUTON A.D. CENTRE : Assembly Rooms, Town Hall, Luton, Repetition of A.D. Chairman's Address, "Years of Development," R. A. Wilson-Jones, 7.30 p.m.
Thurs., Jan. 8.—EASTERN GRADUATES' SECTION : College of Further Education, Williams Street, Slough, "Expansion in Steel Pipes with Special Reference to Steel Bellows," V. Westerman, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : Gas Showrooms, Church Street, Peterborough, "Some Heat Economy Problems in the Sugar Beet Industry," T. Librienski, 7.15 p.m.
Fri., Jan. 9.—ORDINARY MEETING IN CONJUNCTION WITH THE APPLIED MECHANICS GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, "Stress and Deformation Studies for Sandwich Rolling Hard Metals," R. R. Arnold and P. W. Whitton, 6 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., Jan. 6.—SOUTH EASTERN REGION : Peahen Hotel, St. Albans, Herts, "Industrial Research," P. Spear, 7.30 p.m.
Wed., Jan. 7.—WOLVERHAMPTON SECTION : Town Hall, Wednesbury, Staffs, "Current Profile Milling and High Speed Surface Broaching Techniques," A. R. Hambridge, 7.15 p.m. ★ NORTH MIDLANDS REGION : Reform Club, Victoria Street, Nottingham, Graduates' Meeting, 7 p.m.
Thurs., Jan. 8.—SOUTHERN REGION : Social Club, Petters Bryce, Staines, "Fuel Injection Equipment for Oil Engines—Some Aspects of Requirements and Production," G. P. Green, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Jan. 5.—NORTH EASTERN SECTION : Eldon Grill, Grey Street, Newcastle upon Tyne, "Hose Manufacture," C. W. Evans, 7 p.m. ★ PRESTON SECTION : Bull and Royal Hotel, Church Street, Preston, "History of the Rubber Industry," T. H. Messenger, 7.15 p.m.
Thurs., Jan. 8.—BURTON-ON-TRENT SECTION : Midland Hotel, Station Street, Burton-on-Trent, "Work Study and Productivity," J. B. Kitchen, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Fri., Jan. 2.—WESTERN COUNTIES BRANCH : University Engineering Laboratories, Bristol, "Model Analysis of Structures," A. W. Hendry, 6 p.m.
Tues., Jan. 6.—NORTHERN IRELAND BRANCH : College of Technology, Belfast, "The Design of Plate Girders," K. C. Rockey, 6.45 p.m.
Wed., Jan. 7.—NORTHERN COUNTIES BRANCH : Neville Hall, Newcastle, "The Relationship between Contractors and their Clients," W. H. G. Durose, 6.30 p.m.
Thurs., Jan. 8.—11, Upper Belgrave Street, London, S.W.1, "Urban Motorways," G. W. Kirkland, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Jan. 2.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, "Ground Work for Progress," "The England of Elizabeth" and "Round the Island," 7 p.m.
Wed., Jan. 7.—MIDLAND SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, "Brussels Exhibition," W. K. V. Gale, 7 p.m.

PHYSICAL SOCIETY

Sat., Dec. 20.—Cavendish Laboratory, Cambridge, Conference on "Interfacial Phenomena."
Fri. and Sat., Jan. 2 *and* 3.—The University, Birmingham, Conference on "Problems of Collective Motion."

PLASTICS INSTITUTE

Fri., Jan. 2.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Young People's Lecture, "Plastics and Electricity," E. Rushton, 2.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Mon., Jan. 5.—NORTH WESTERN BRANCH : College of Technology, Sackville Street, Manchester, "The Design and Construction of Shell Roofed Buildings for Cadbury Bros., Ltd., at Moreton," J. E. C. Farebrother and L. E. May, 6.45 p.m.
Tues., Jan. 6.—NORTH WESTERN BRANCH : Liverpool Engineering Society, The Temple, 24, Dale Street, Liverpool, "The Design and Construction of Shell Roofed Buildings for Cadbury Bros., Ltd., at Moreton," J. E. C. Farebrother and L. E. May, 6.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., Jan. 5.—ORDINARY GENERAL MEETING : 12, Great George Street, Westminster, London, S.W.1, "Building Societies in the Contemporary Scene," Sir Harold Bellman, 5.45 p.m.

SOCIETY OF CHEMICAL INDUSTRY

To-day, Dec. 19.—CORROSION GROUP : 14, Belgrave Square, London, S.W.1, "Modern Views of Electrochemical Processes" ; "Cathodic Processes," E. C. Potter, 2.30 p.m., and "Anodic Processes," T. P. Hoar, 5.30 p.m.
Tues., Jan. 6.—CORROSION GROUP : Birmingham and Midland Institute, Paradise Street, Birmingham, "Alloys for High Temperature Service," D. A. Oliver, 6.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Mon., Jan. 5.—CONTROL SECTION : Manson House, Portland Place, London, W.1, "Control Systems as Applied to Railways Signalling," J. C. Kubale, 6 p.m.

Advanced Engineering Courses

Statistical Quality Control. INSTITUTE FOR ENGINEERING PRODUCTION, THE UNIVERSITY OF BIRMINGHAM, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. The course is designed for members wishing to apply the techniques of statistical quality control. The course will be held from 9.30 a.m., Monday, February 9, until 3.30 p.m., Friday, February 20, 1959. Fee 50 guineas.

Linear and Non-Linear Servo Control Systems. SOUTH EAST LONDON TECHNICAL COLLEGE, Lewisham Way, London, S.E.4. Short course of ten lectures on Wednesday evenings, commencing January 21, 1959. Fee £1.

Circuit Elements and their Use in Electrical Measurements. MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, Manchester, 1. Course of six lectures on Wednesdays from 7 to 9 p.m., commencing January 14, 1959. Fee £1 5s.

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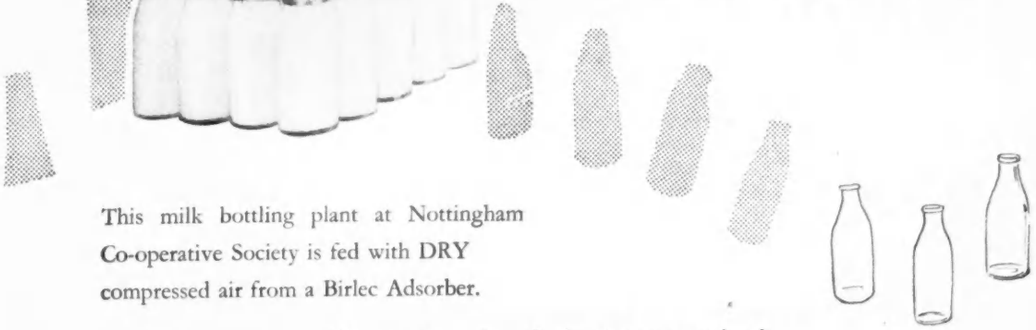

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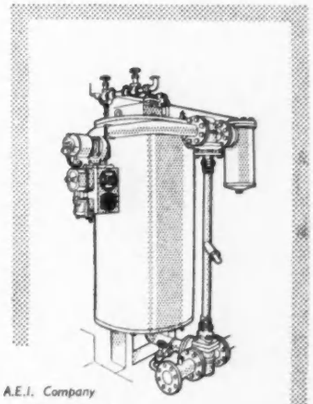

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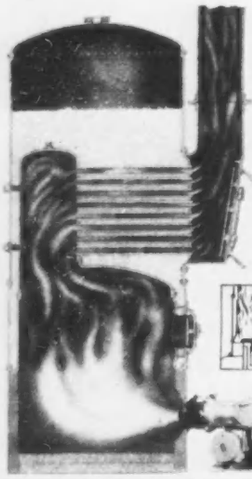

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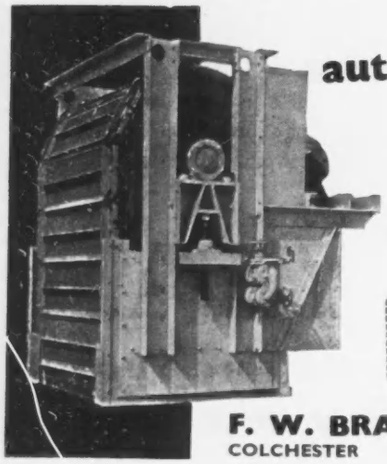

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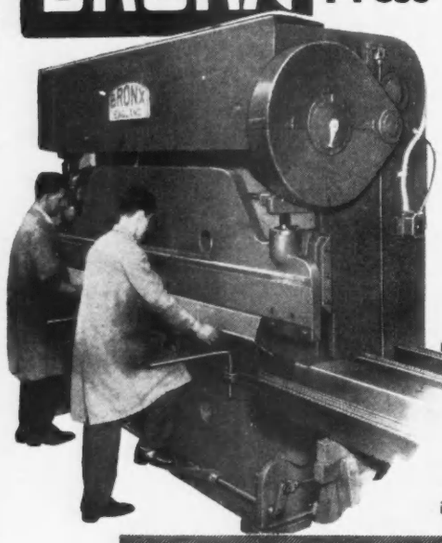

Illustration shows a "Bronx" 40 ton Press Brake engaged upon the manufacture of lighting reflectors, at the works of Messrs. Ionlite, Ltd., 89, Scrubs Lane, London, N.W.10. For forming sections in all metals, in all thicknesses, up to 20ft. wide—Bronx Press Brakes are faster and more versatile than folding machines and can be tooled for punching, shearing and notching. Range of sizes from 20 to 1,000 tons pressure.

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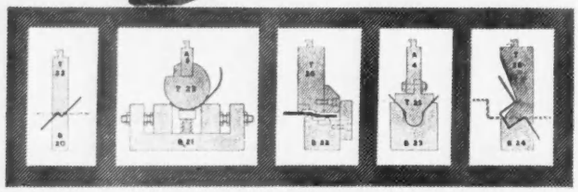

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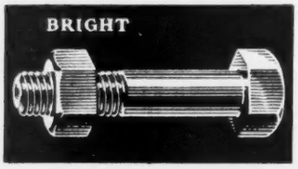

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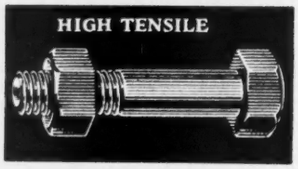

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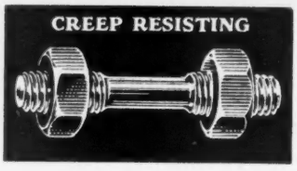

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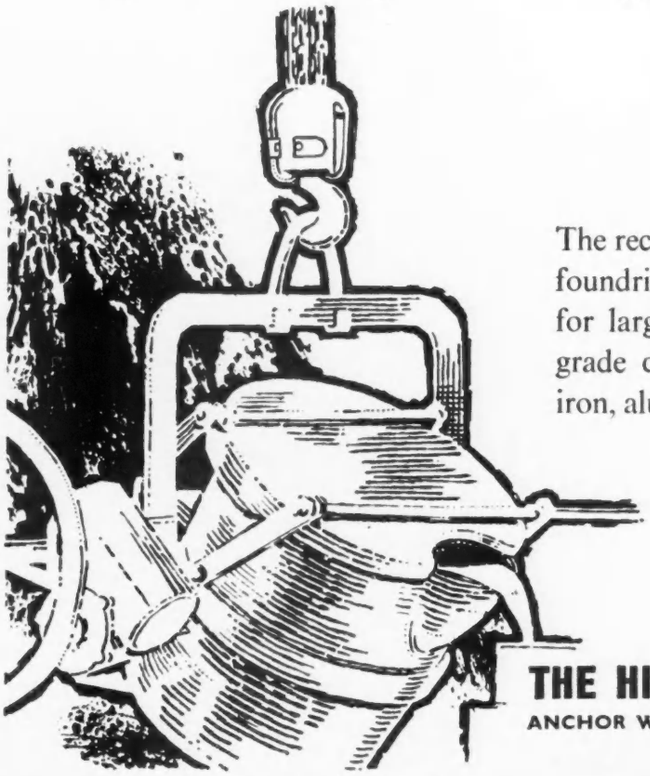

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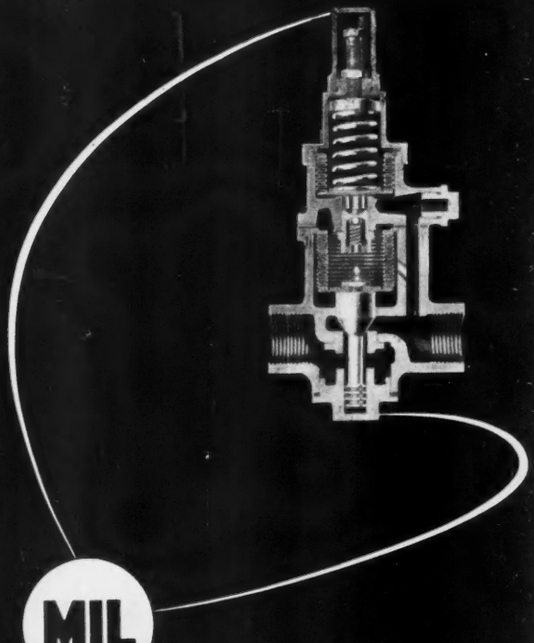

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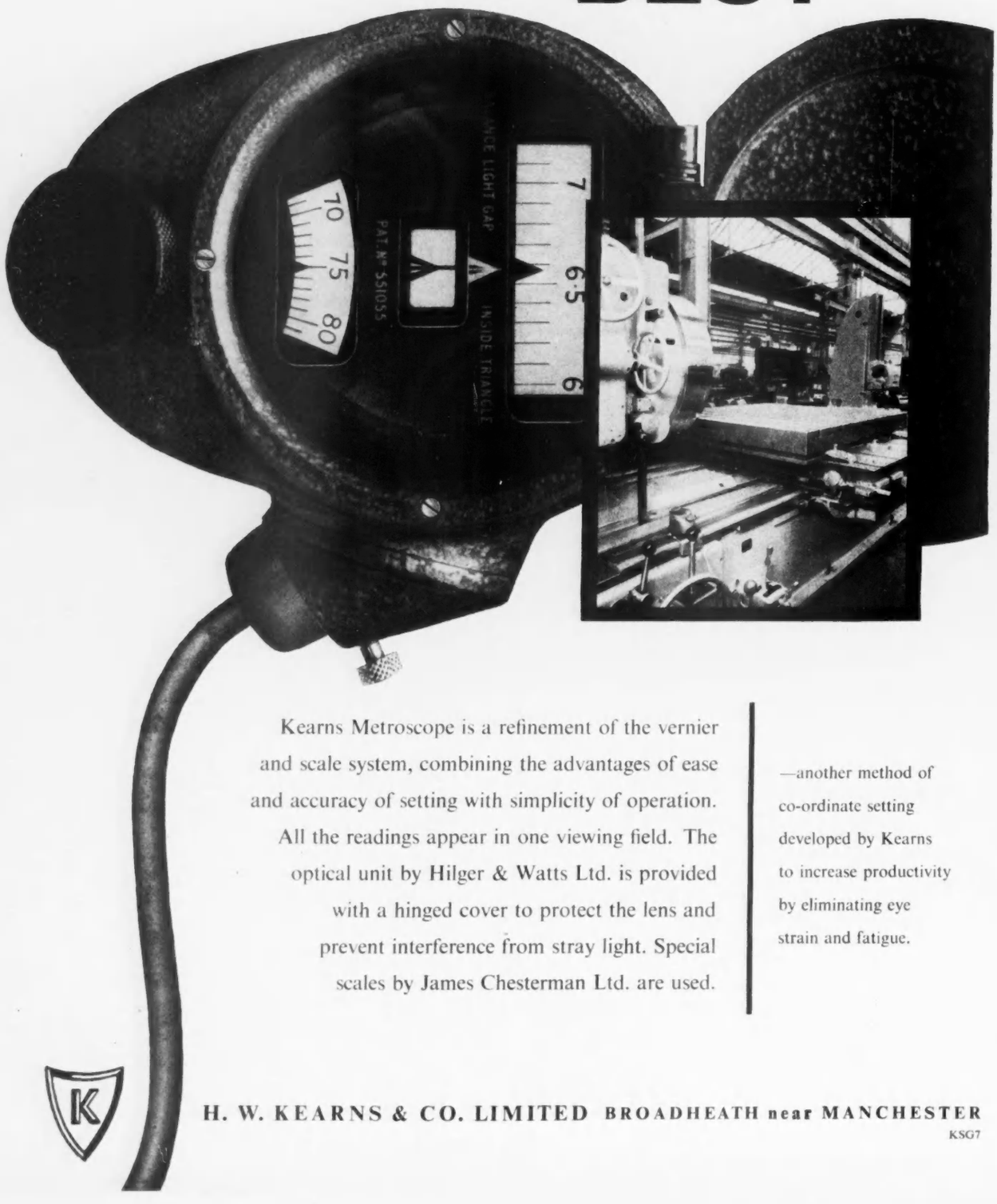

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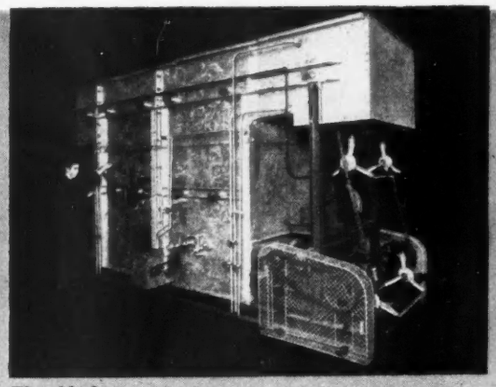
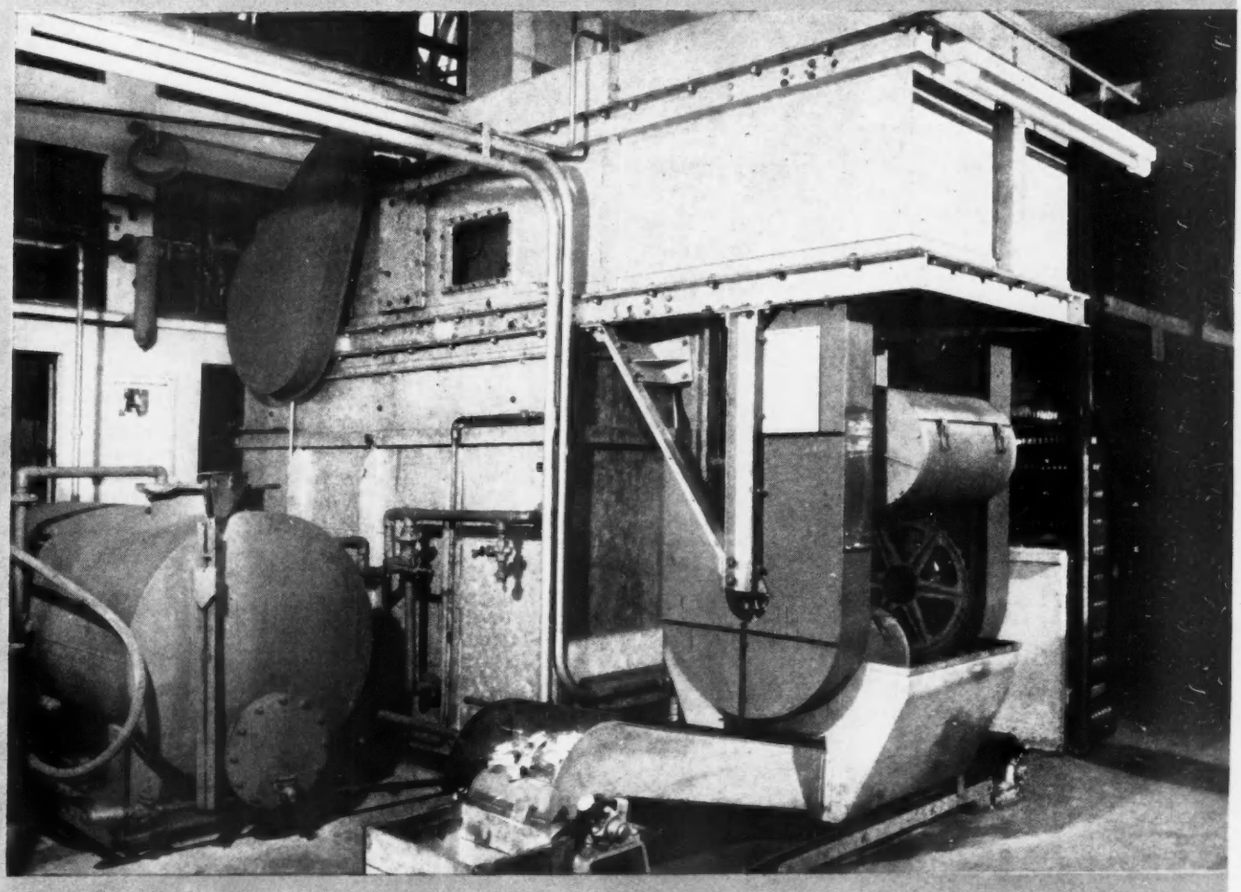


The old plant

One good plant sells another



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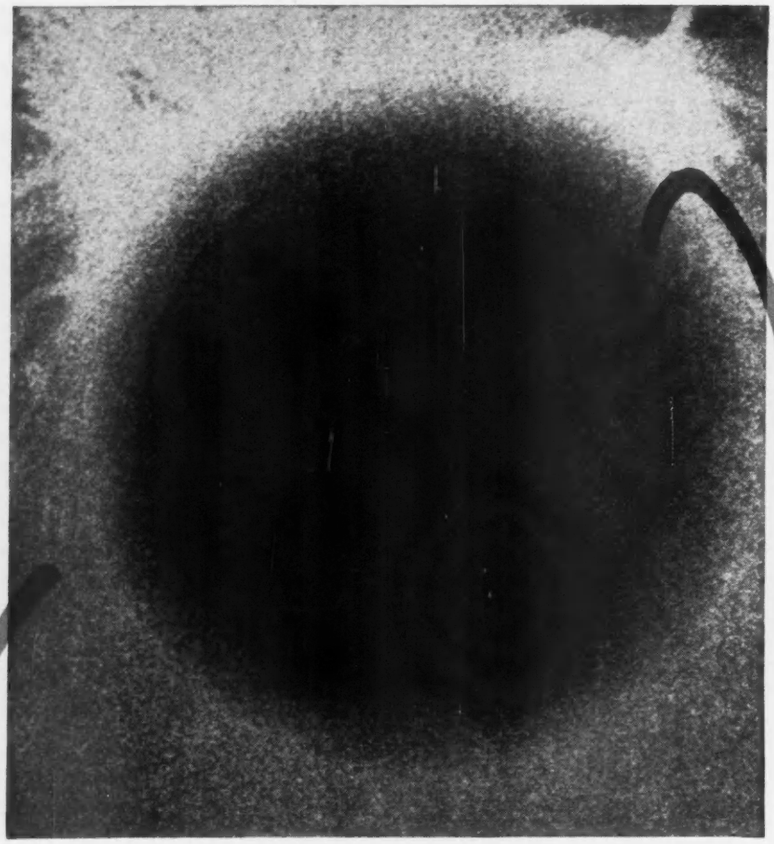

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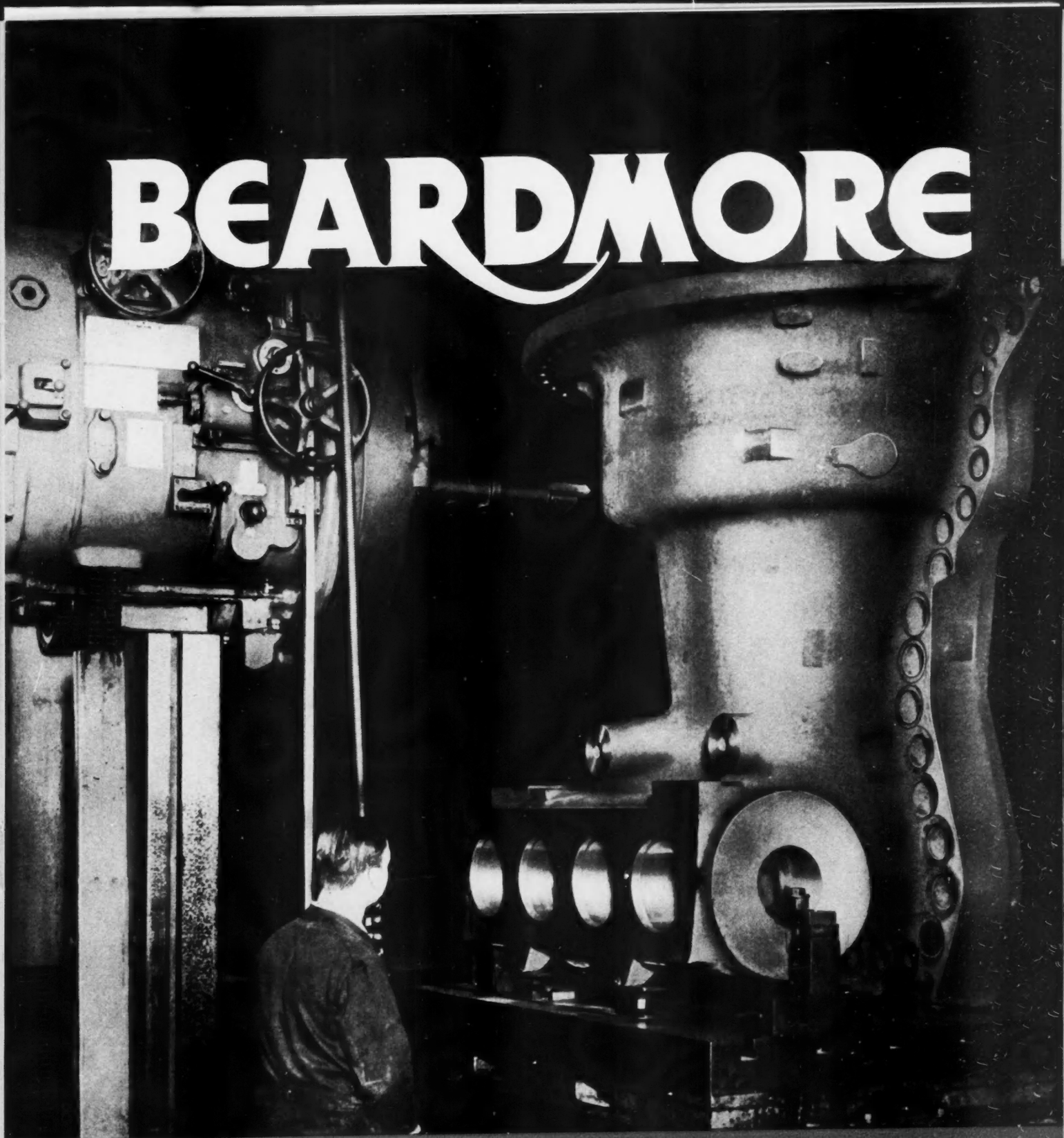

Illustration: Beardmore casing for 30 MW steam turbine H.P. cylinder half-casing, in the Trafford Park works of Metropolitan-Vickers Electrical Company Limited.

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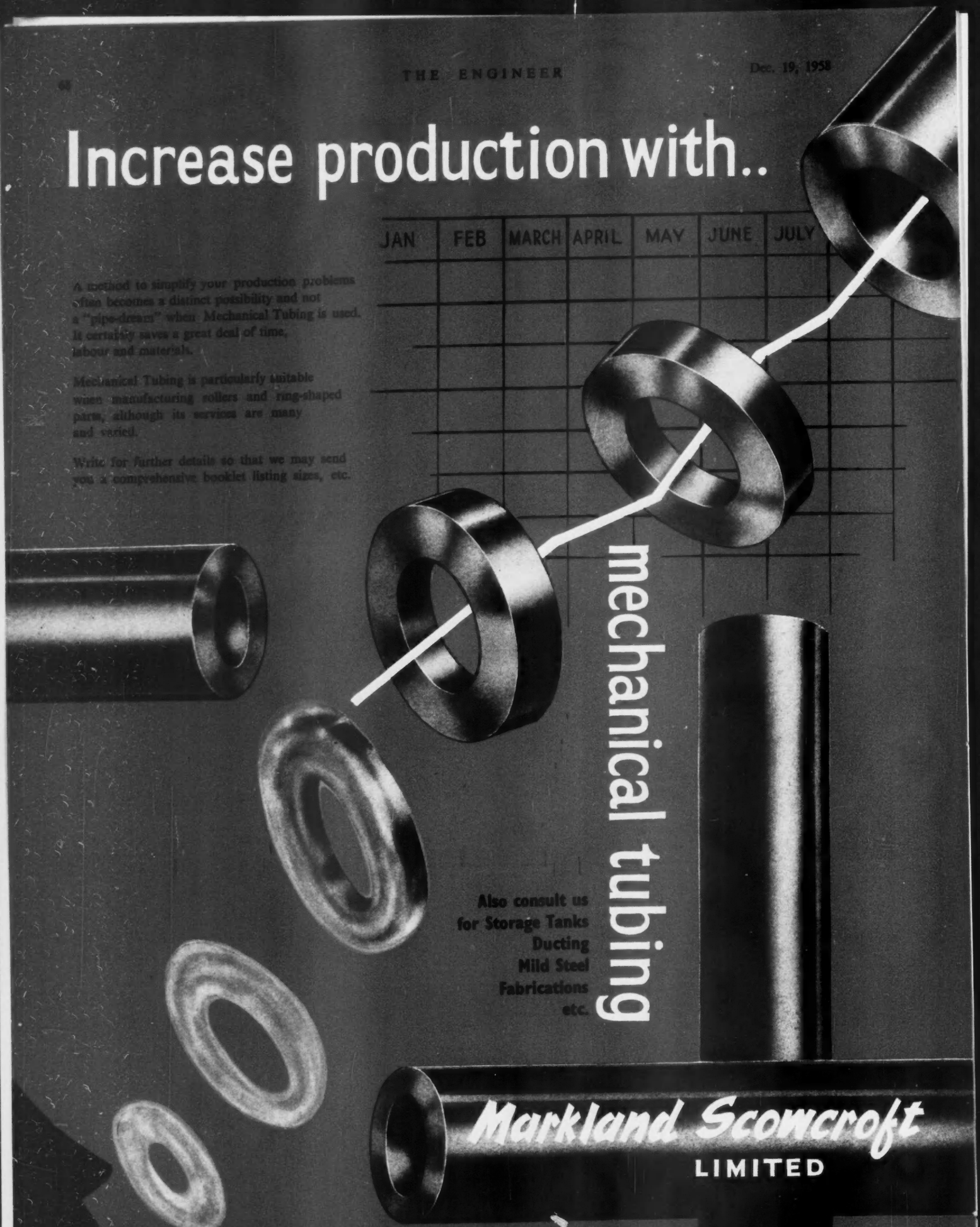

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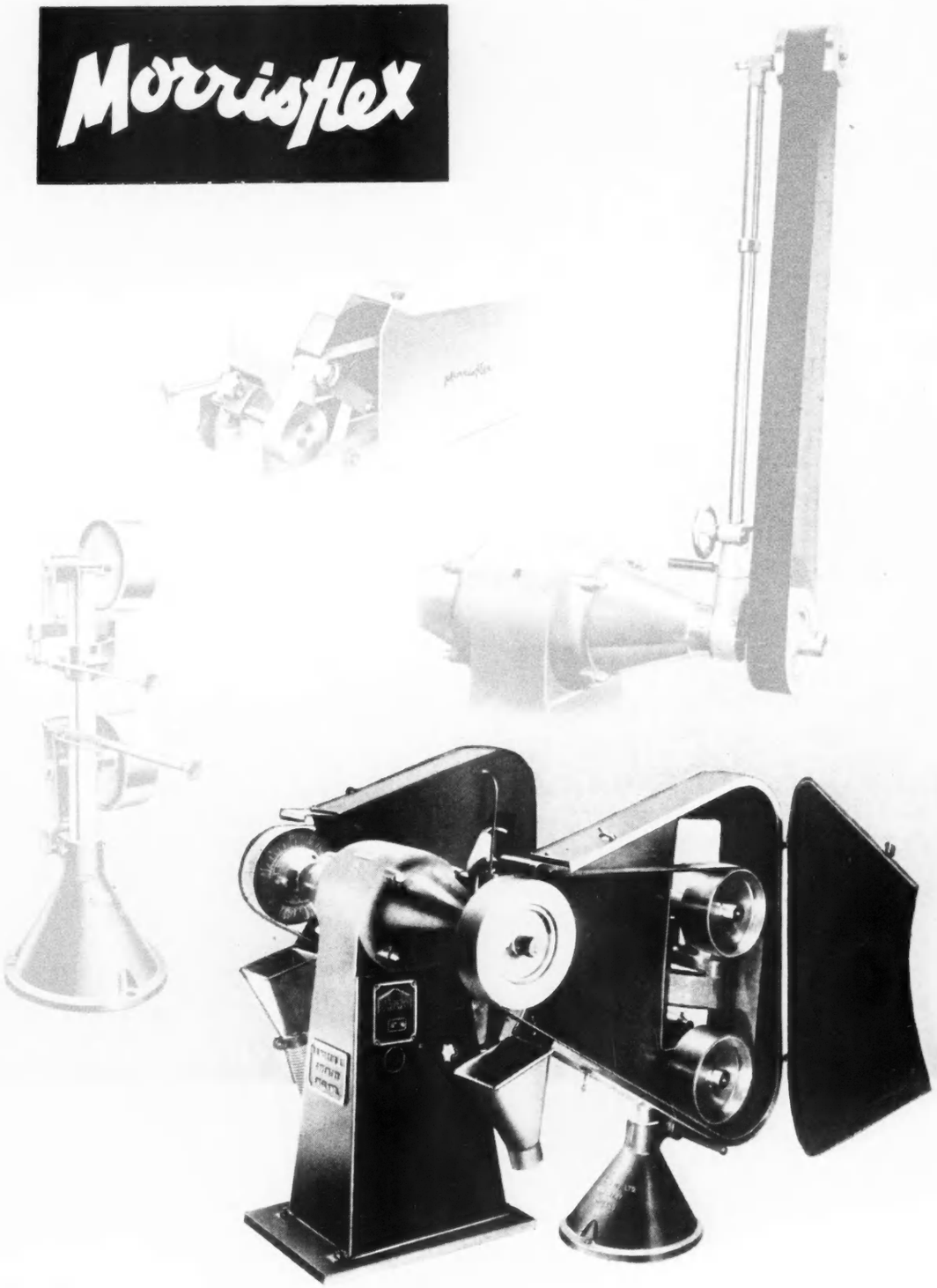

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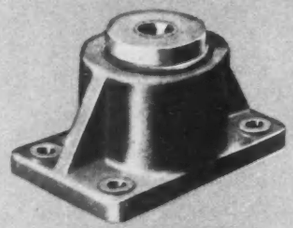
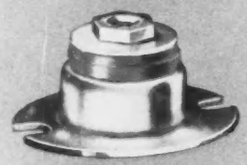
General type (triangular flange)

Pedestal assembly



Pedestal mounting

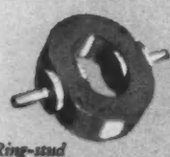
Frustacon type



FN type

Instrument type (pedestal flange)

Instrument type (square flange)



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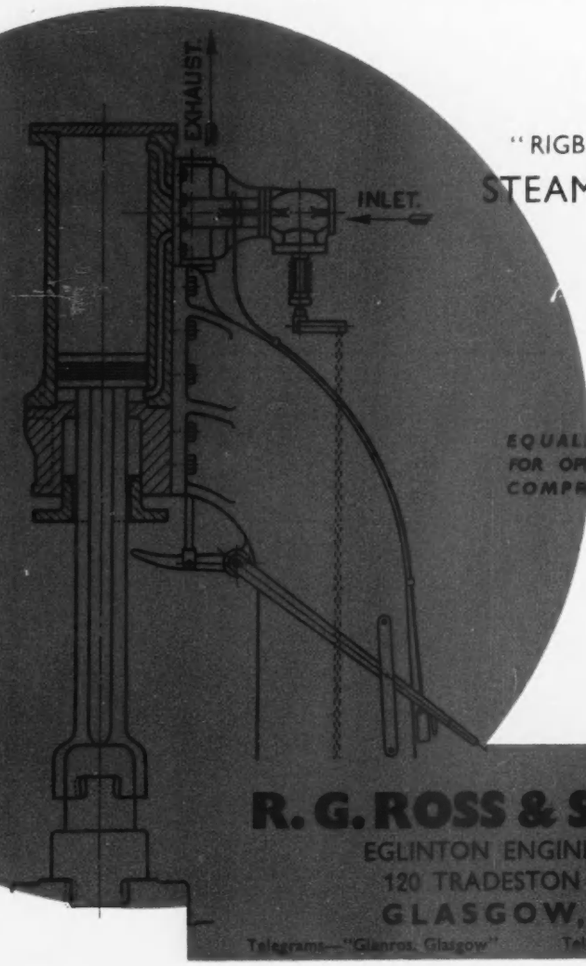

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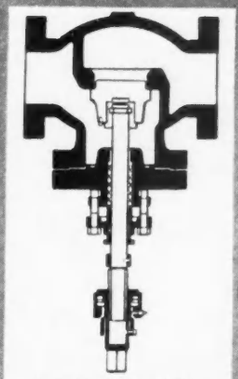
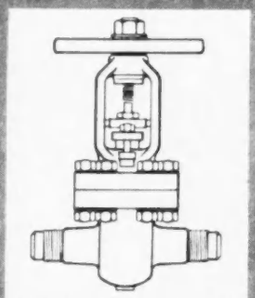
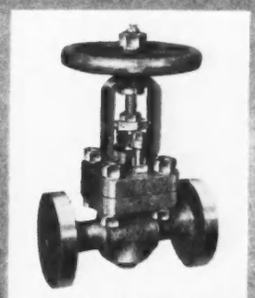

Astern Double Shut-off Valve.


F.S. Parallel Slide Valve. 1400 p.s.i.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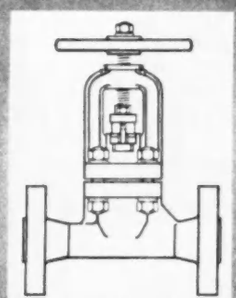
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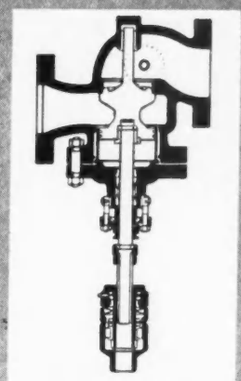
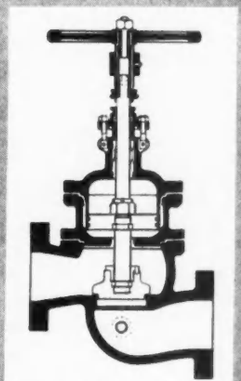

Manœuvring Valve.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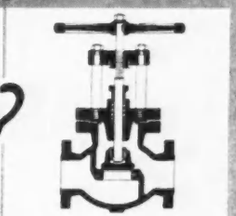
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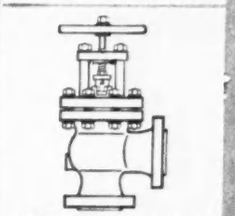
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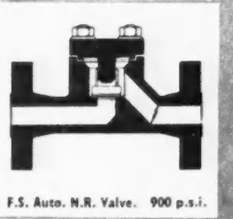
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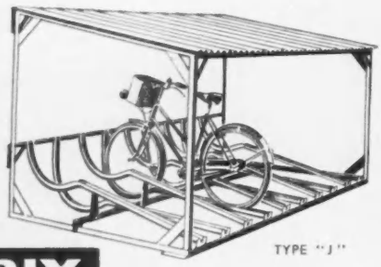

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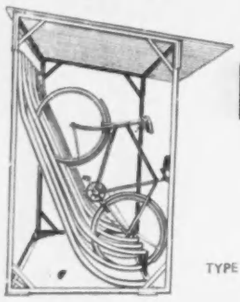

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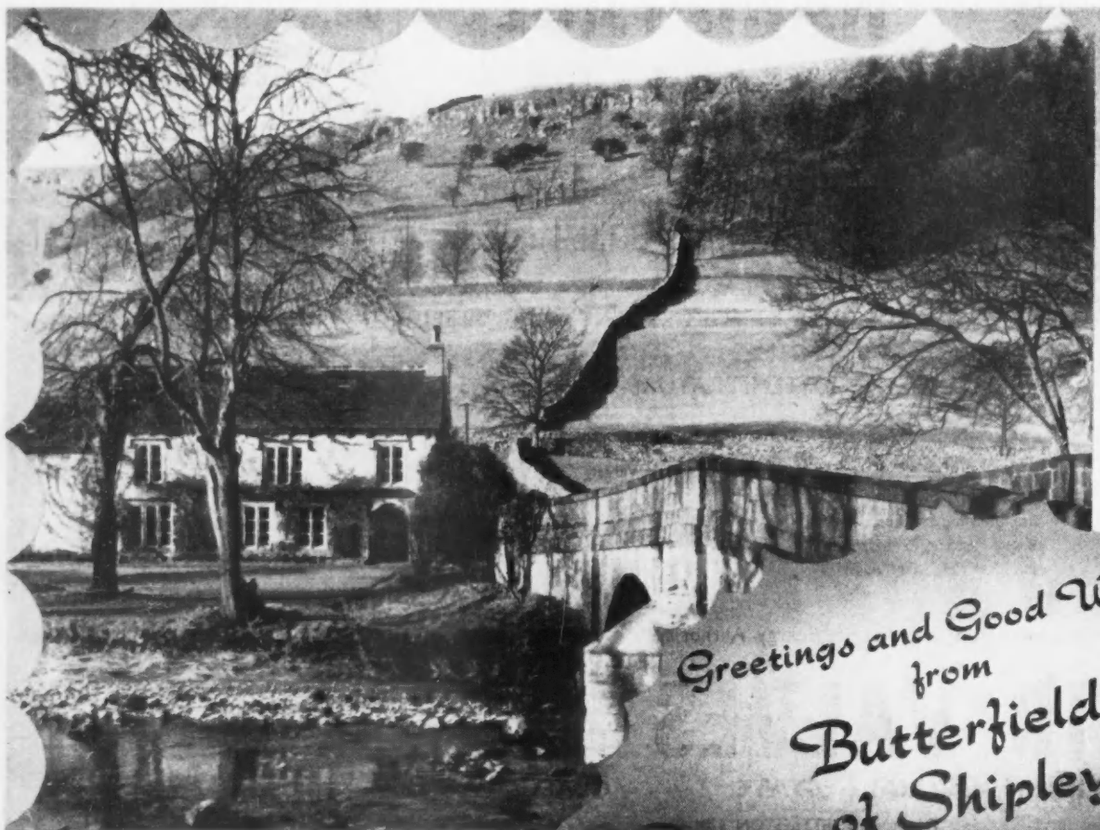

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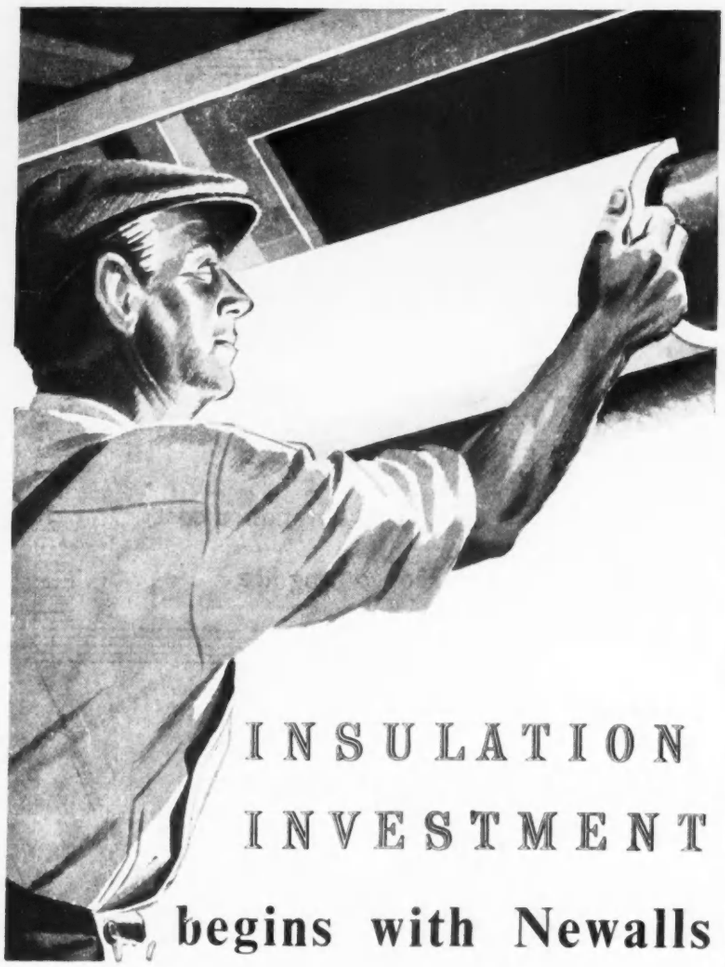

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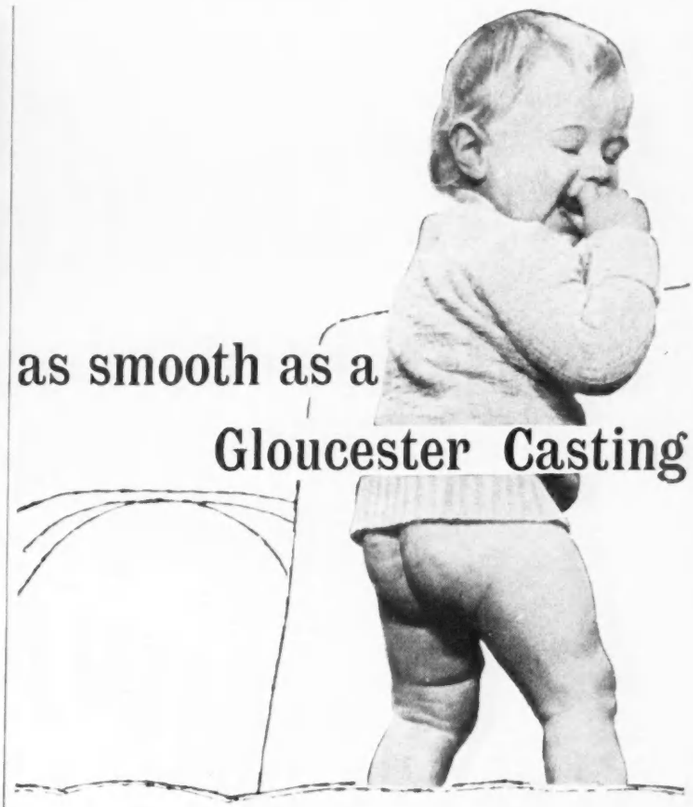

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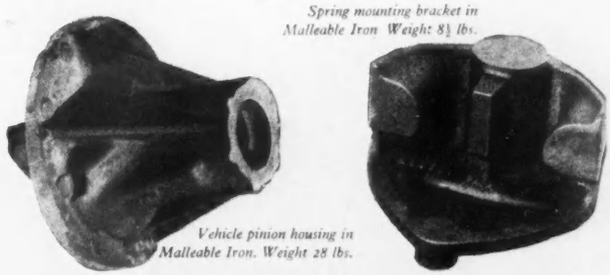

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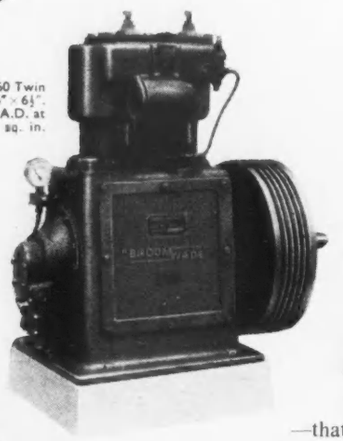

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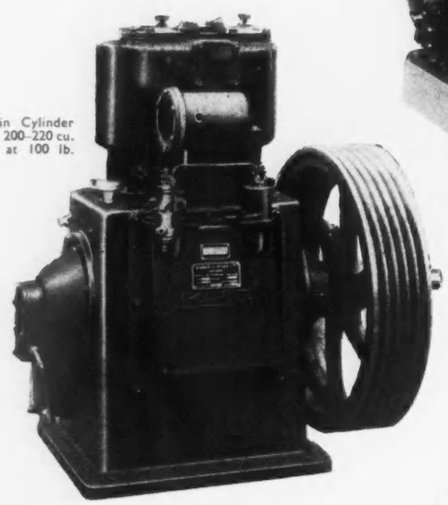

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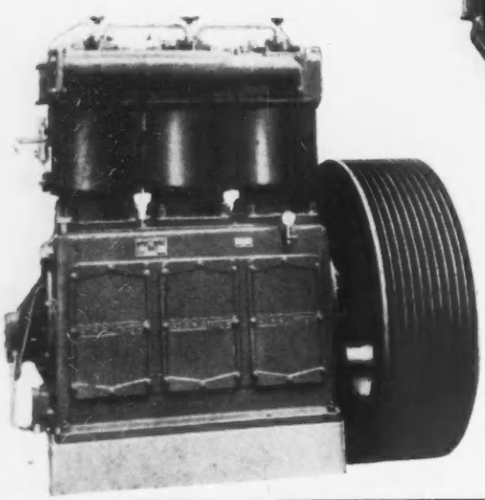

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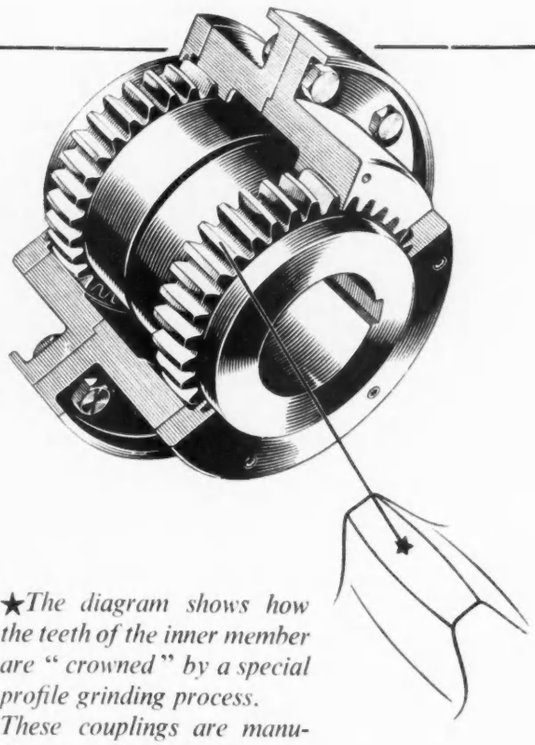

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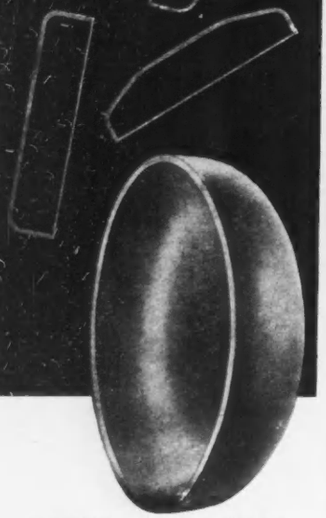

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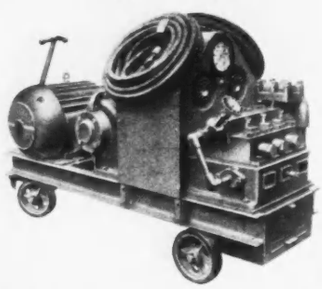

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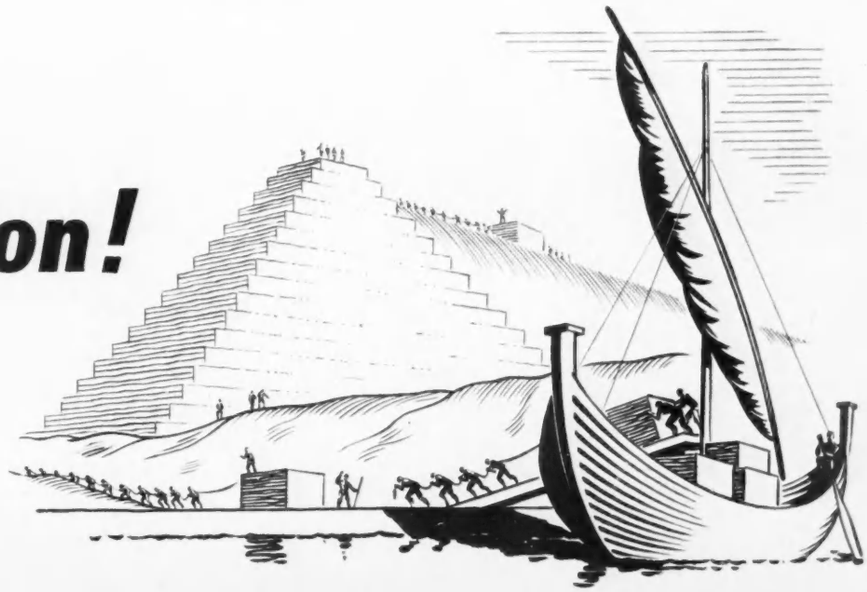

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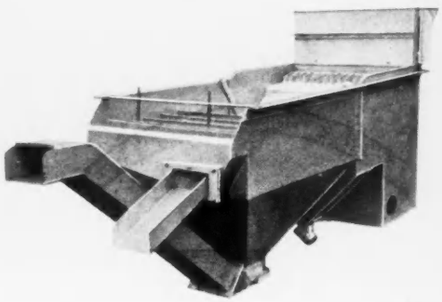
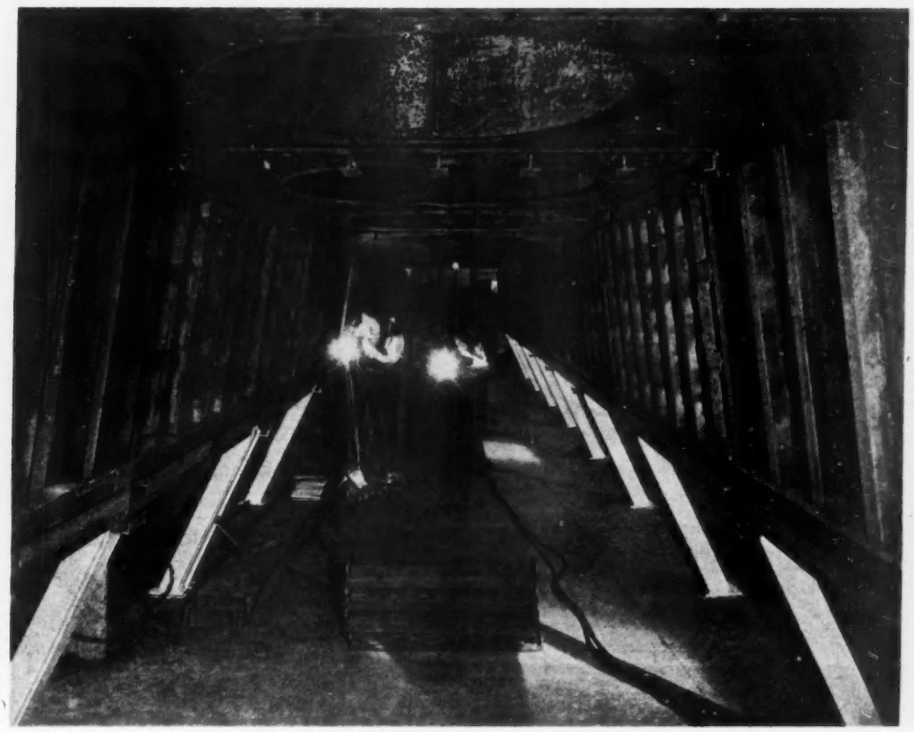


▲ *Continuous process vegetable washing & grading machine*



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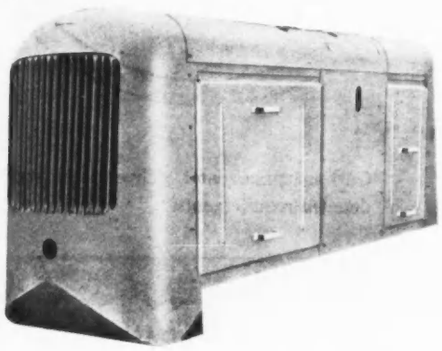

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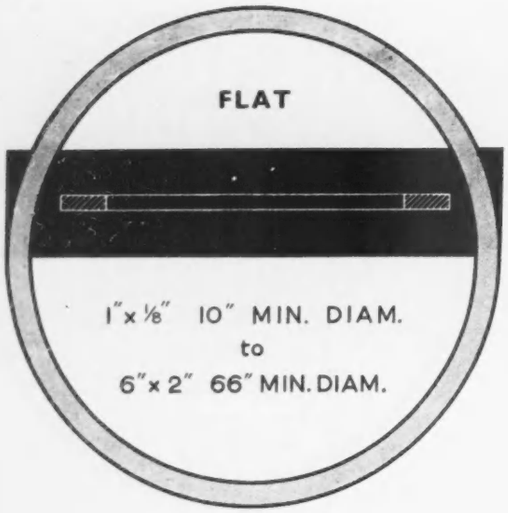

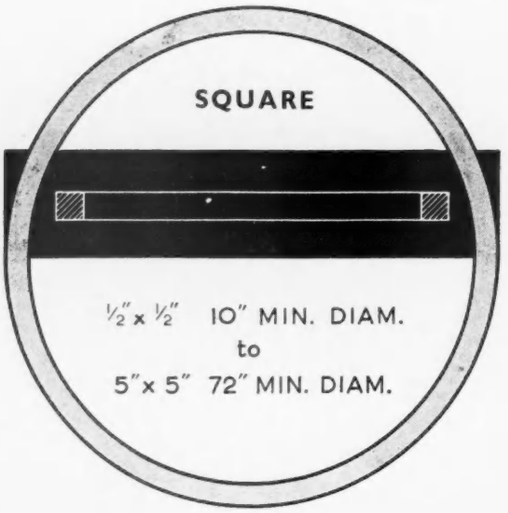

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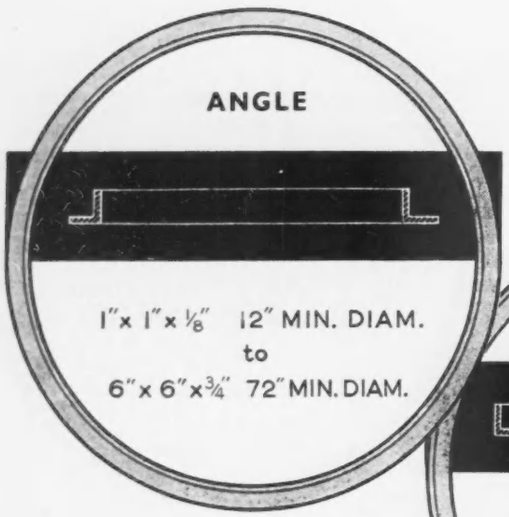

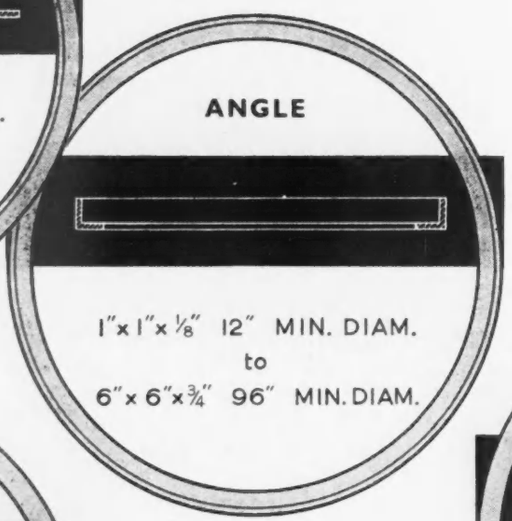

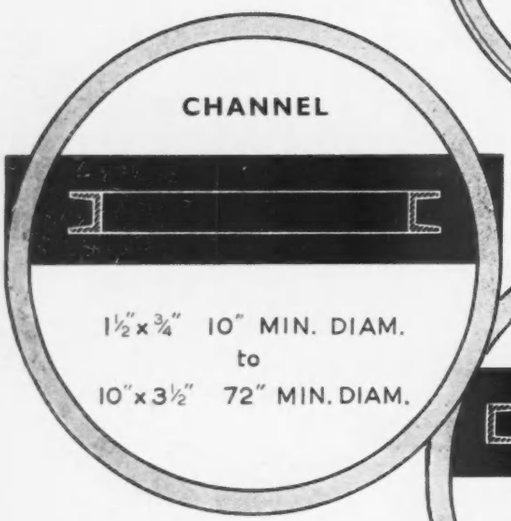

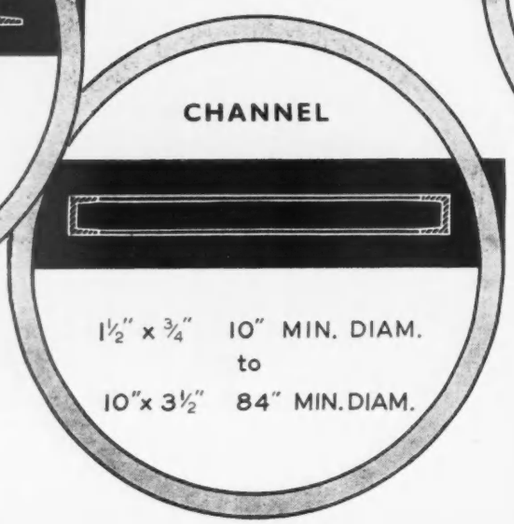

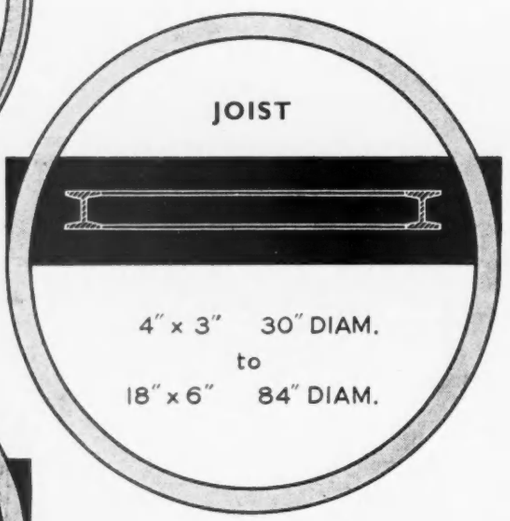

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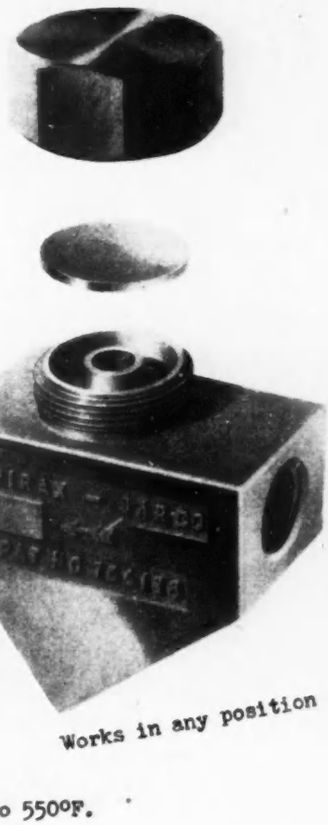
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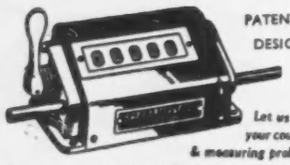

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There is an 'ALBION' ratchet or revolution counter for every application. Fit your machines with these efficient counting instruments which will show your output at a glance.

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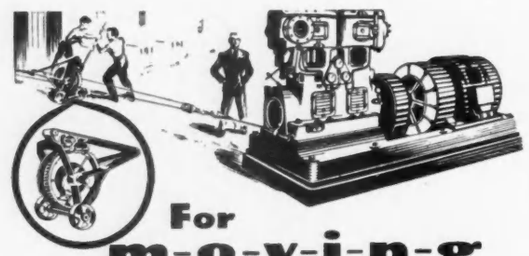

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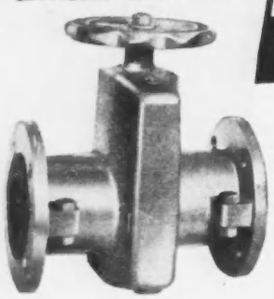

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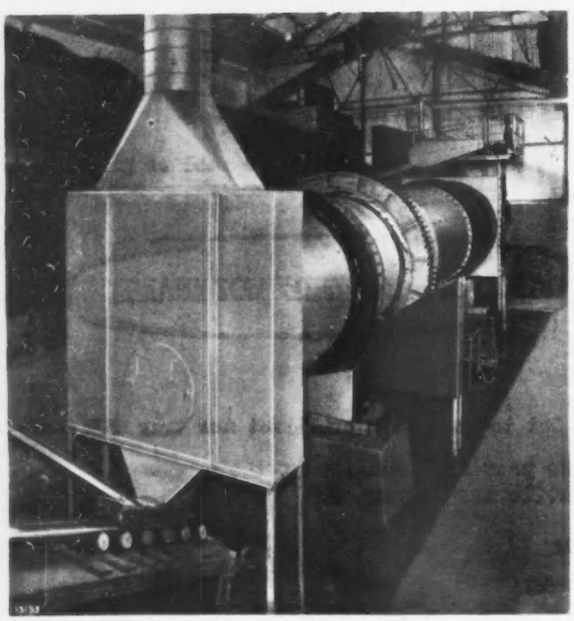

This Sturtevant Rotary Dryer dries sand to zero moisture content. It is direct oil-fired and is equipped with a specially designed belt feeder for the wet sand.

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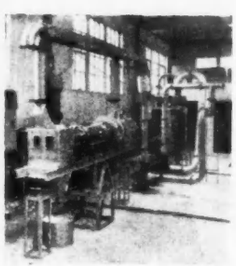
Chemicals in granular form, minerals, ores, sand, clay, and sugar, are some examples of materials efficiently dried by this method.

Sturtevant Rotary Dryers are designed for direct or indirect drying. Where contamination or corrosion must be avoided they are lined or made in stainless steel.

Write to our reference E/101/Z for further particulars.



The Sturtevant Laboratory Rotary Dryer. Full facilities are available in our laboratories for testing clients materials.

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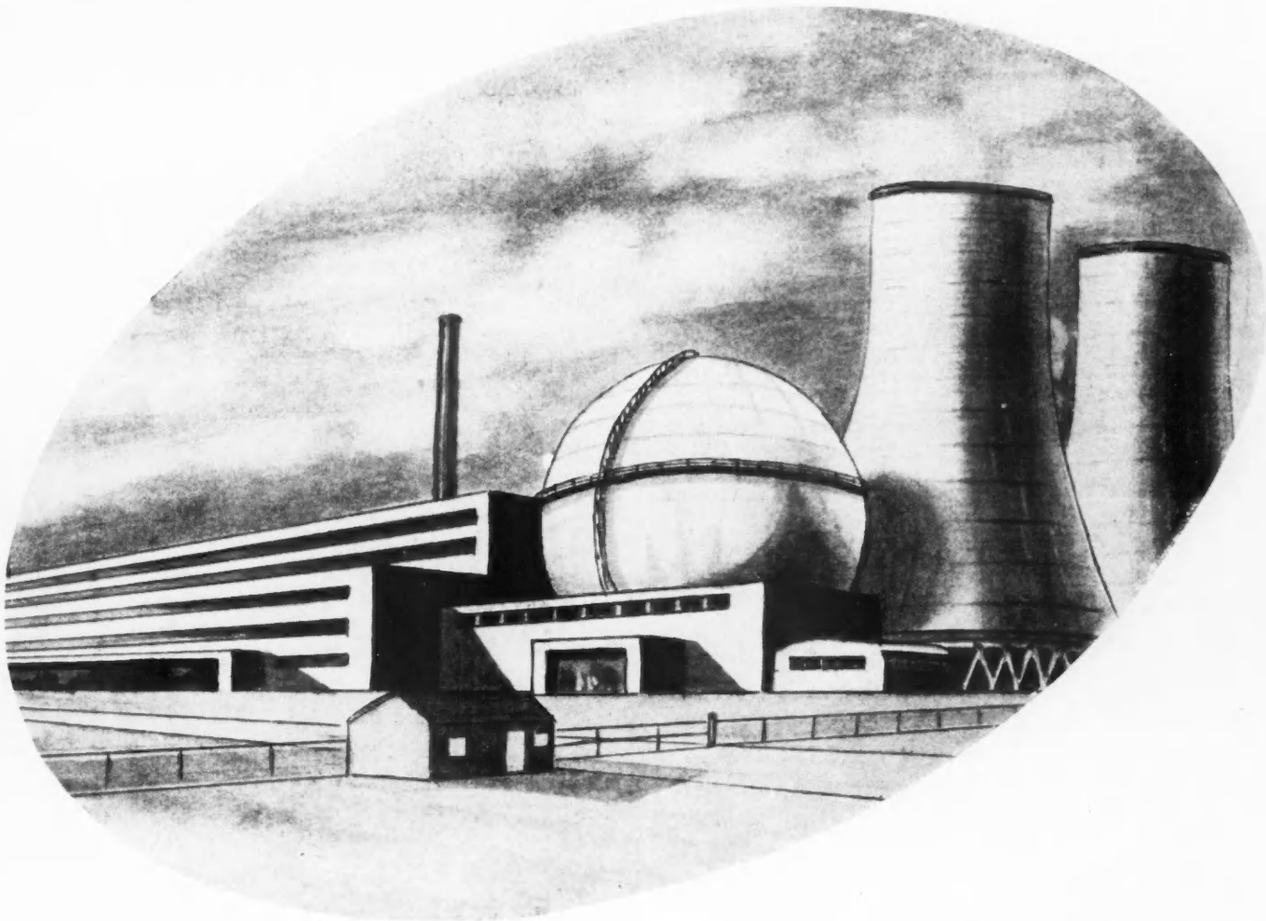

as, in the fullness of time, like all marvels of modern engineering, it *must*. . . . But why the dismay? . . . The scrap it yields will be remelted and reborn to make steel for constructing even greater engineering marvels. . . .

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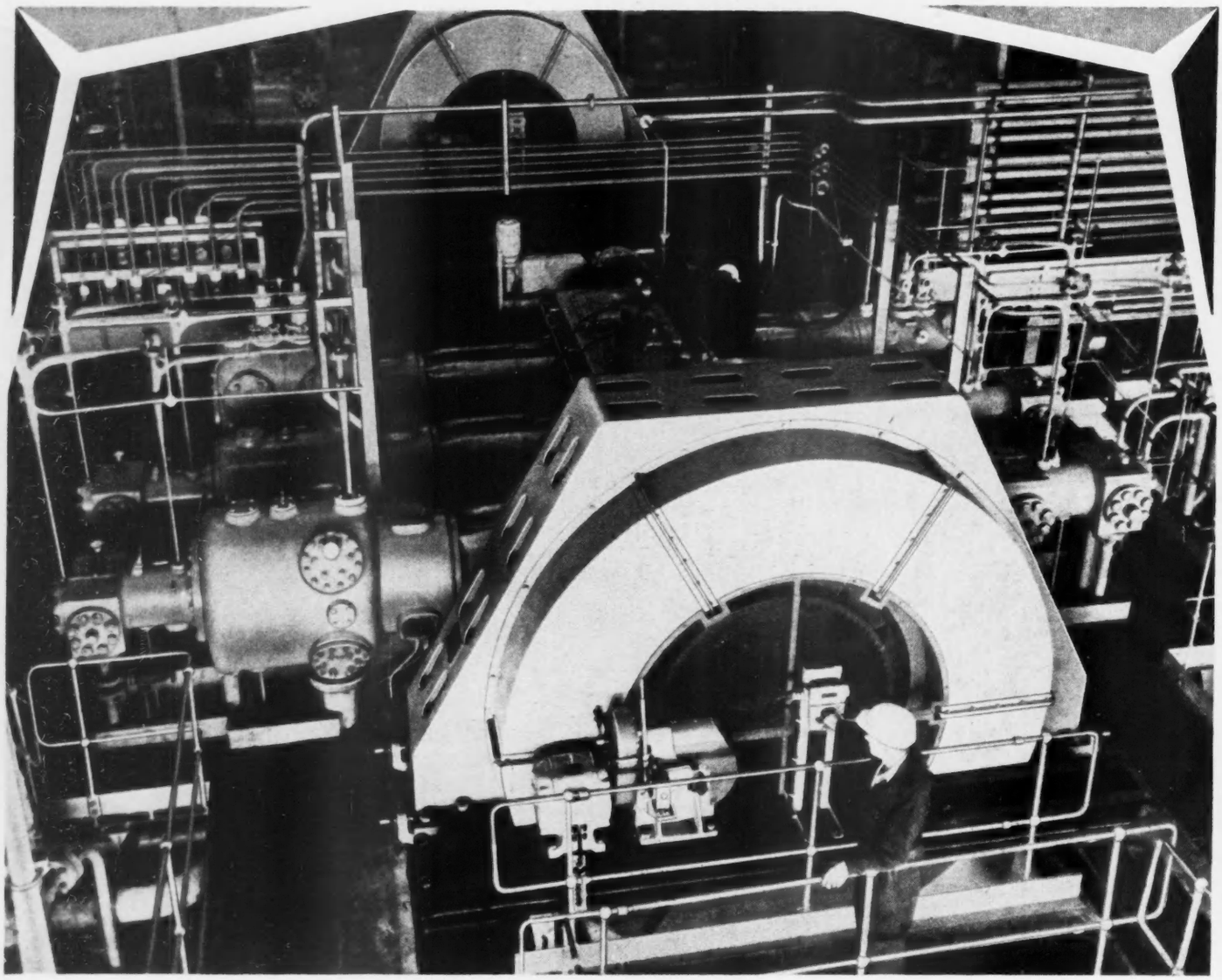

drives for the chemical industry

Two 2,750 h.p. squirrel cage induction motors driving compressors which deliver hydrogen and nitrogen at approaching 300 ats. for the synthesis of ammonia at the Billingham Works of the I.C.I.

The normal industrial type of protected enclosure is used on these machines although some sections of this chemical factory handle explosive gases. This is another instance where the electrical plant and areas of a chemical installation have been classified according to their respective ignitive and explosive tendencies and a consequent economic saving has been achieved.

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THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Electrical Plant Sales, Stafford

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Worldwide

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You may know some of the men who sell WHARTON cranes. But you won't know the men who actually build them. And that's a pity.

We know them. We know the excellence of their work, the skill and experience which they use to such good—and lasting—effect.

Eric Ward, for instance. He began learning about WHARTON cranes when he joined our machine shop 39 years ago, to be followed 25 years later by his son Donald.

"It's the sort of place," says Eric, "where you can put your heart into the job and know that people appreciate your work. And there's always plenty of it. I've been on overtime since 1927."

It's natural that the Wards and others like them are busy. Because people DO appreciate cranes built by such craftsmen . . . WHARTON cranes.

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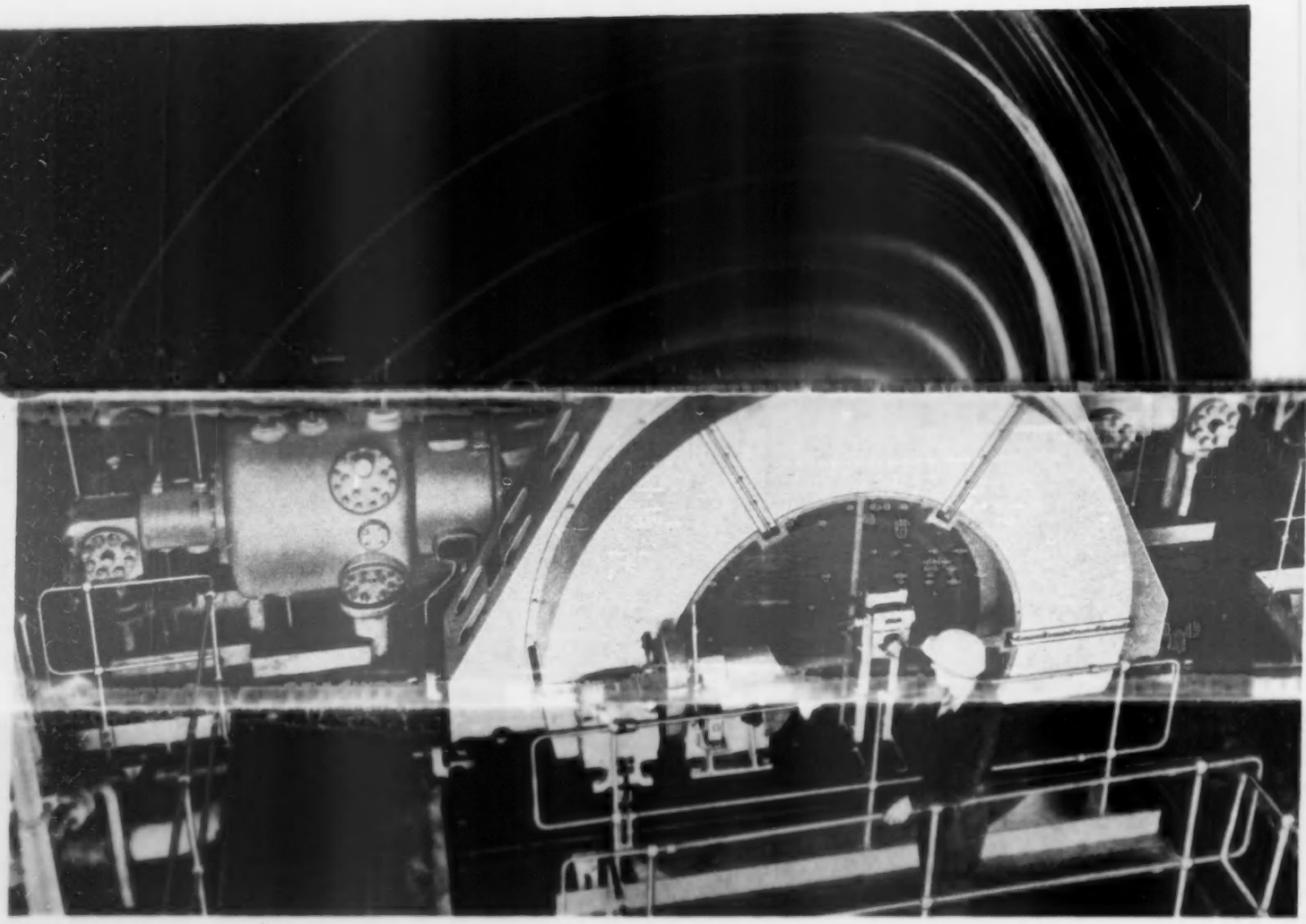

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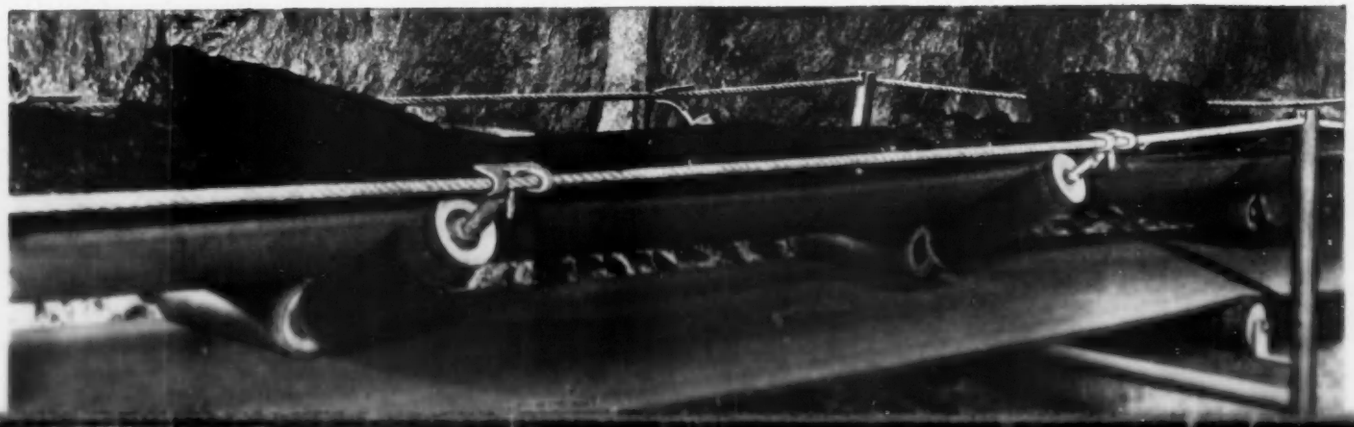

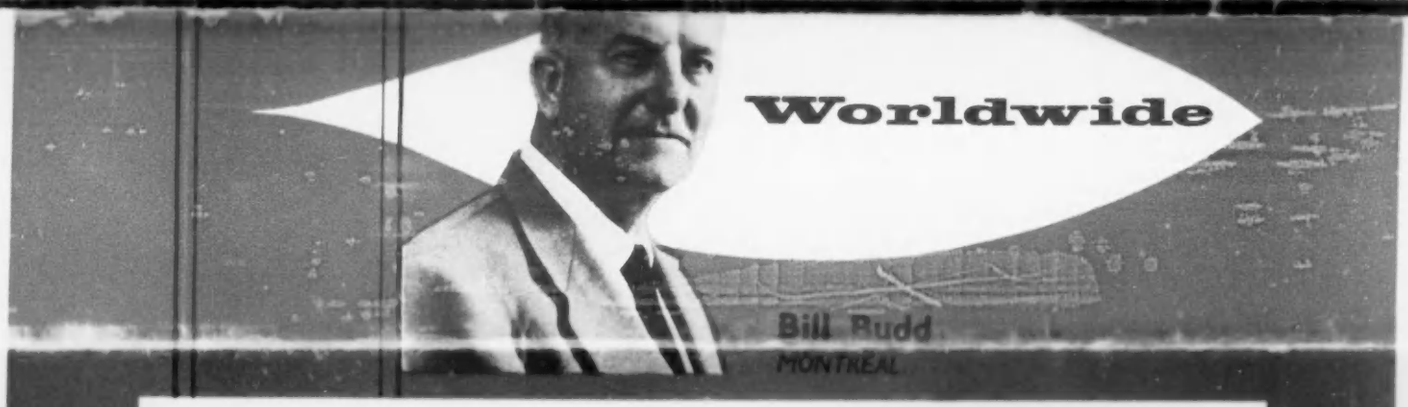

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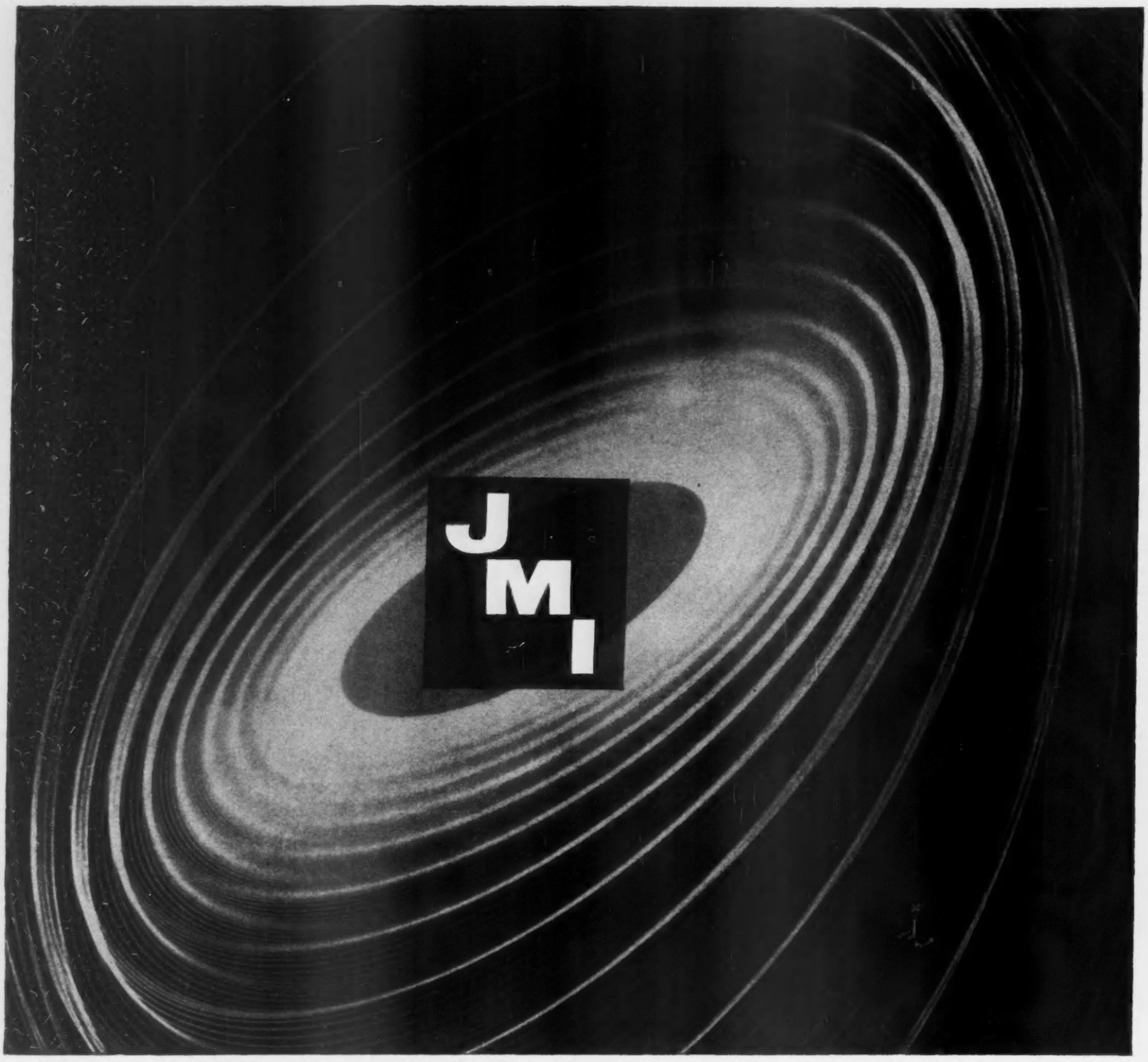

Scrutiny of youth

It is certainly the prerogative—and almost the duty—of each generation to question the ideas and loyalties of its predecessors. Were it not so progress would be slow indeed.

But to question does not always mean to reject. In industry, for instance, there are many examples of 'conservative' loyalties withstanding the fresh and searching scrutiny of youth.

There are enduring names in British industry, long-established companies whose own successive generations have contributed much to progress—without impairing that aura of un-noisy efficiency and complete dependability commanding a degree of confidence yesterday that is endorsed today and will be endorsed tomorrow.

We are very proud that year after year we continue to be numbered among them.

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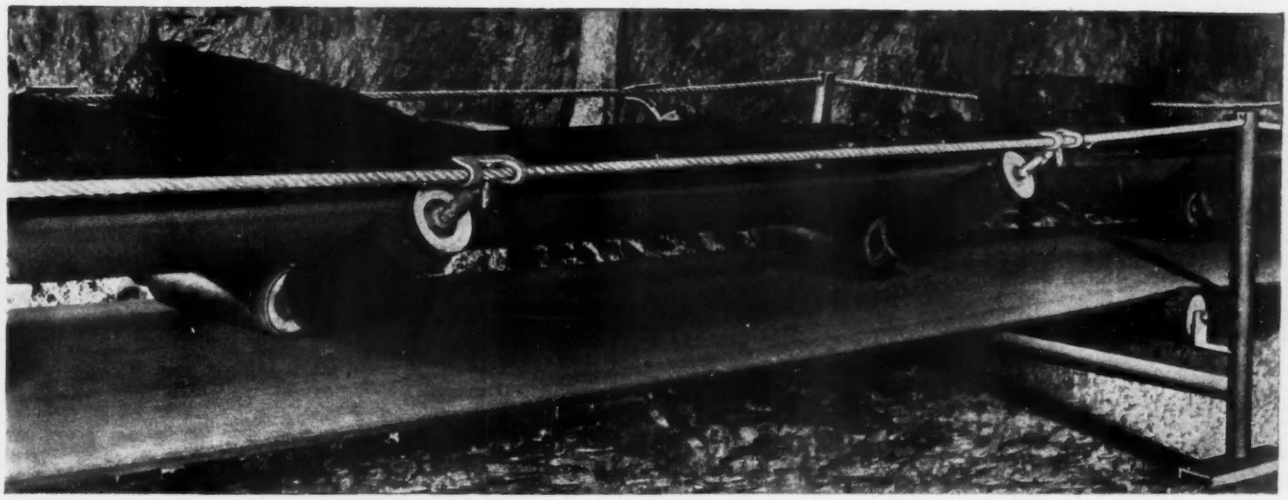
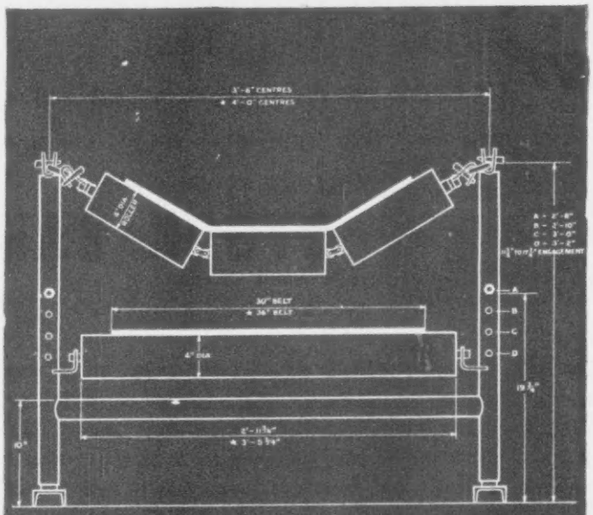
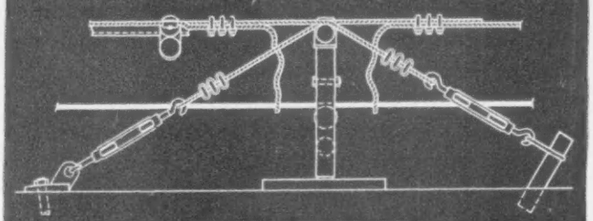




INTERMEDIATE STAND
(Adjustable for height)



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NEW RESILIENT

Distington - Goodman

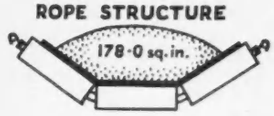
BELT CONVEYOR STRUCTURE

(Patented)

- *increases belt life*
- *reduces installation costs*
- *increases capacity*
- *almost eliminates spillage*
- *inexpensive*

CONVENTIONAL STRUCTURE

ROPE STRUCTURE



Greater conveying capacity obtainable by increased troughing under load

The longitudinal members of this conveyor structure consist of $\frac{5}{8}$" dia. steel ropes in tension. The connections at the ends of each troughing idler shaft are hinged. These basic features provide a resilient conveyor which is easy to stack, transport and install — a conveyor in which impact damage to the belt as it passes over the idlers is greatly reduced. The belt is easy to train. The bottom belt is in full view and there need not be any concealed rubbing between belt and structure.

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Meehanite stock bars can be machined into Gears, Rings, Discs, Collars and many other components applicable to all branches of industry. There is a growing demand for a material which will conform to the various stringent specifications, depending on the user's application. Meehanite stock bars meet this demand in a form which offers convenience of stocking and speed of despatch.

No one type of iron is suitable for every type of service and Meehanite stock bars are produced under four general classifications according to the purposes for which they are likely to be required.

FREE! Write for the Meehanite Machining Chart a 28" x 22" wall chart giving speed-seed tables and all relevant machining information.

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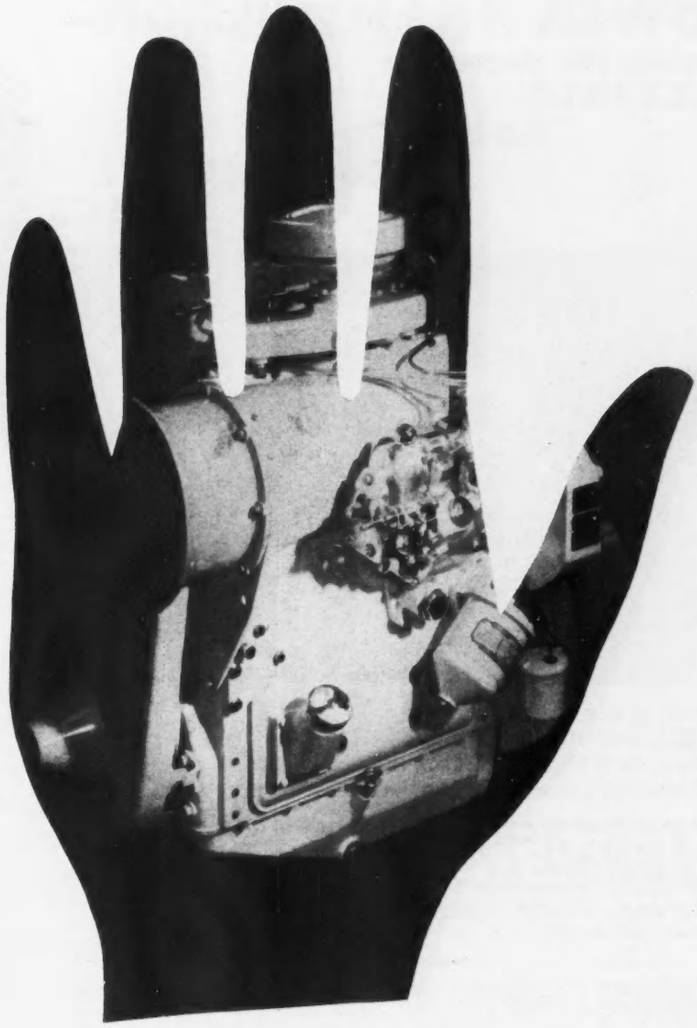
Cast Iron Can Do it-if it's

MEEHANITE REGD

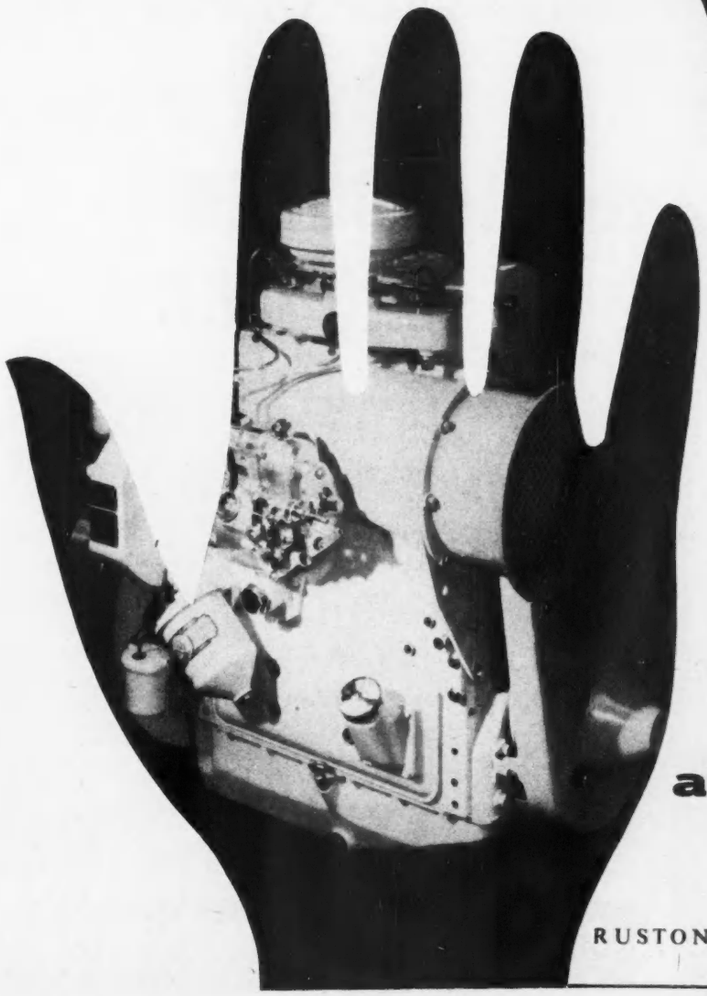
The Dependable Metal

THE INTERNATIONAL MEEHANITE METAL COMPANY LTD., MEERION HOUSE, 4 DOWNSIDE, EPSOM, SURREY. TEL: EPSOM 3507/8

either-handed



Let's face it, there are often two sides to a diesel user's problem. That's why we designed our YDA air-cooled diesels 'either-handed' With the YDA, all accessories and control gear are on one side of the engine—whichever side ***you*** *want it.* ***And*** *full power can be taken from either end of the crankshaft for 'either-way' rotation.*



Versatility of application is just one of many outstanding features of the new Ruston 'Y' range air-cooled diesels—the most advanced power units of their type. For longer, trouble-free service, easier operation and maintenance, and for sheer round-the-clock slogging, insist on

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air-cooled diesels 4-110 b.h.p.

The power units backed by a first-class world-wide spares service to give you complete dependability.

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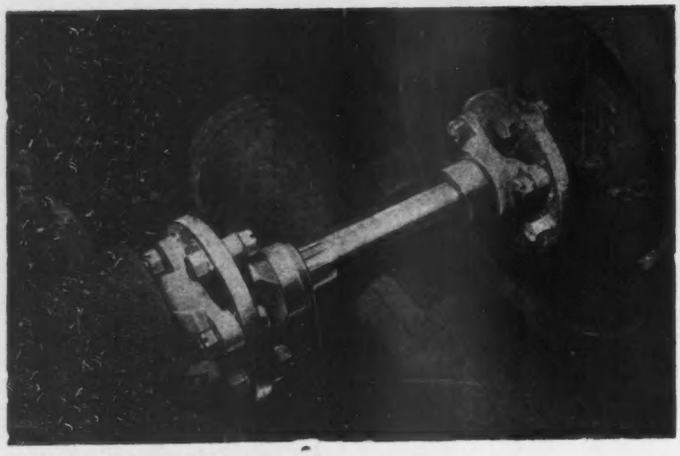
through the medium of
FLEXIBLE
FABRIC
COUPLING
DISCS



★ Are easily assembled.
★ Give extreme torsional flexibility.
★ Absorb irregularities in load variations.
★ Axial and parallel misalignments are corrected.

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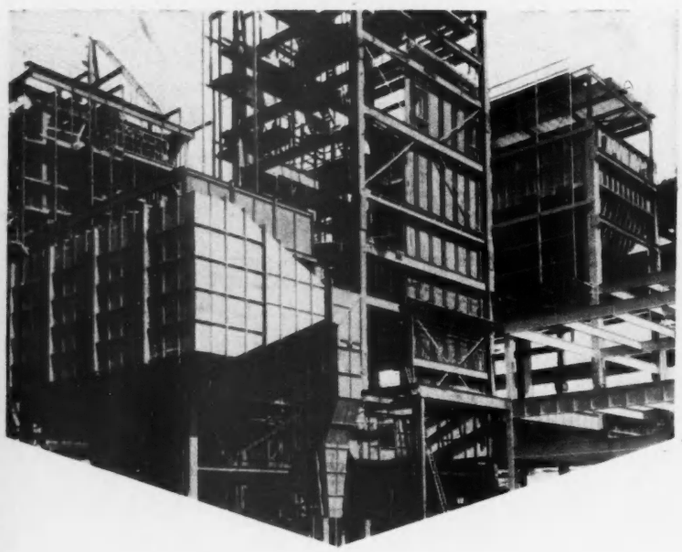

BOILERS UNDER
CONSTRUCTION AT

LITTLE
BARFORD 'B'

by

FOSTER
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for the

CENTRAL
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Illustration shows outdoor installation of 2 P.F. boilers at Little Barford "B" Power Station. Each boiler 550,000 lb/hr; 950 psig; 925° F.

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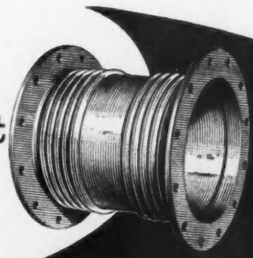
Let's get  together with . . .

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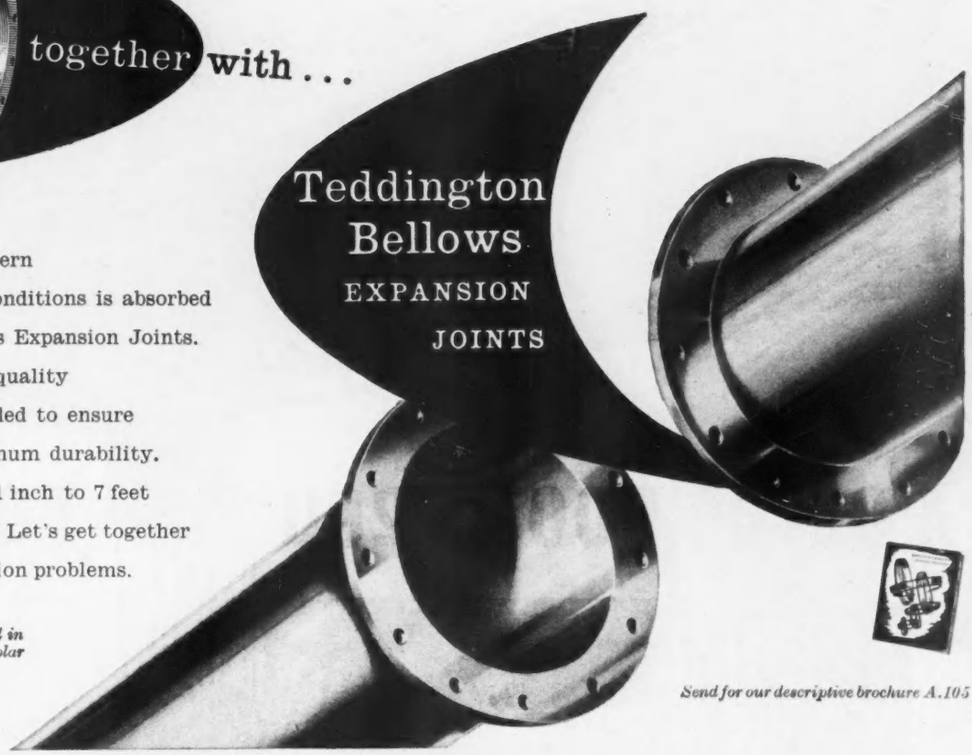

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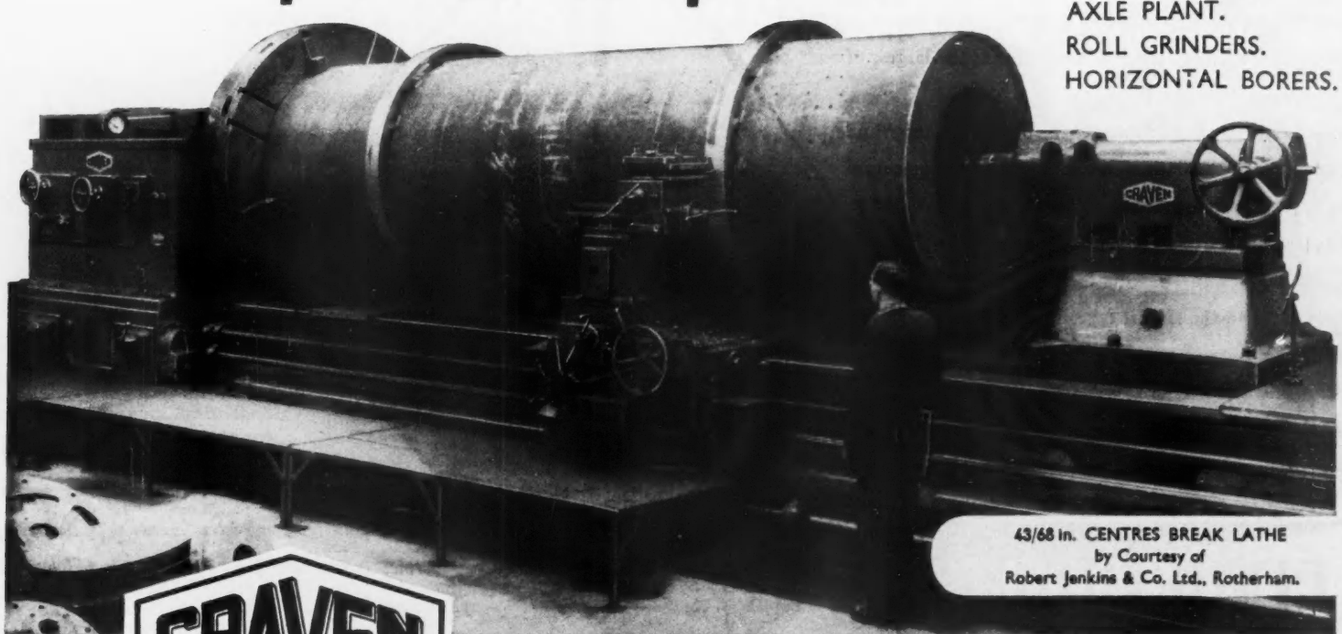

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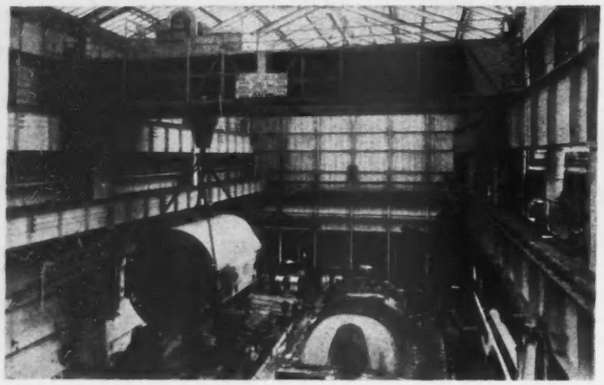

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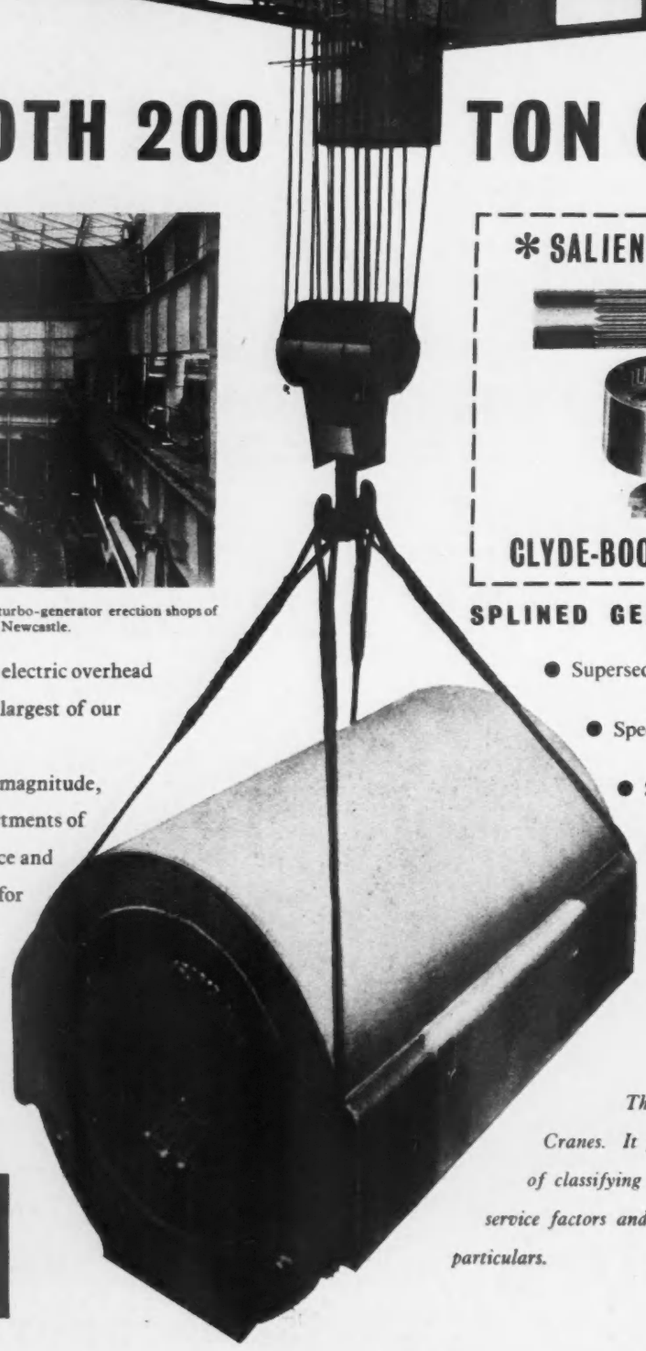

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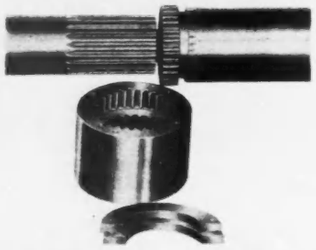

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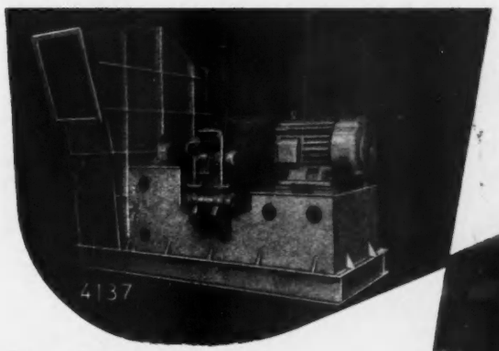

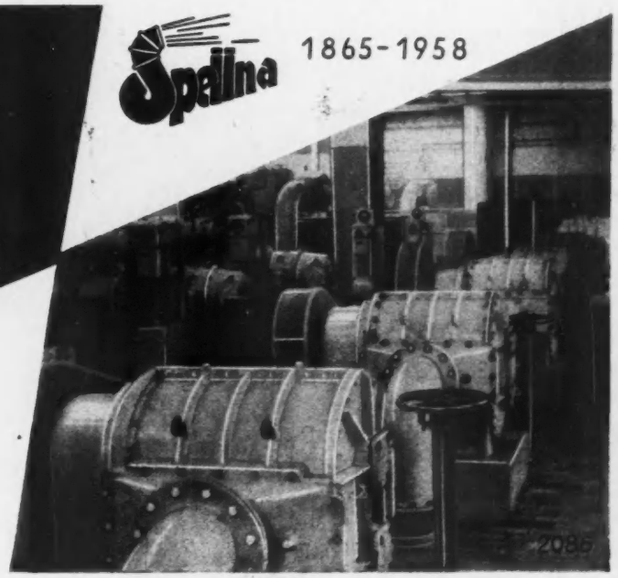

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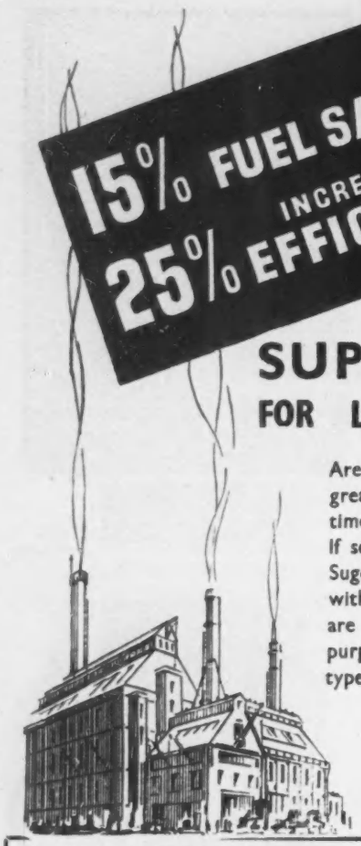

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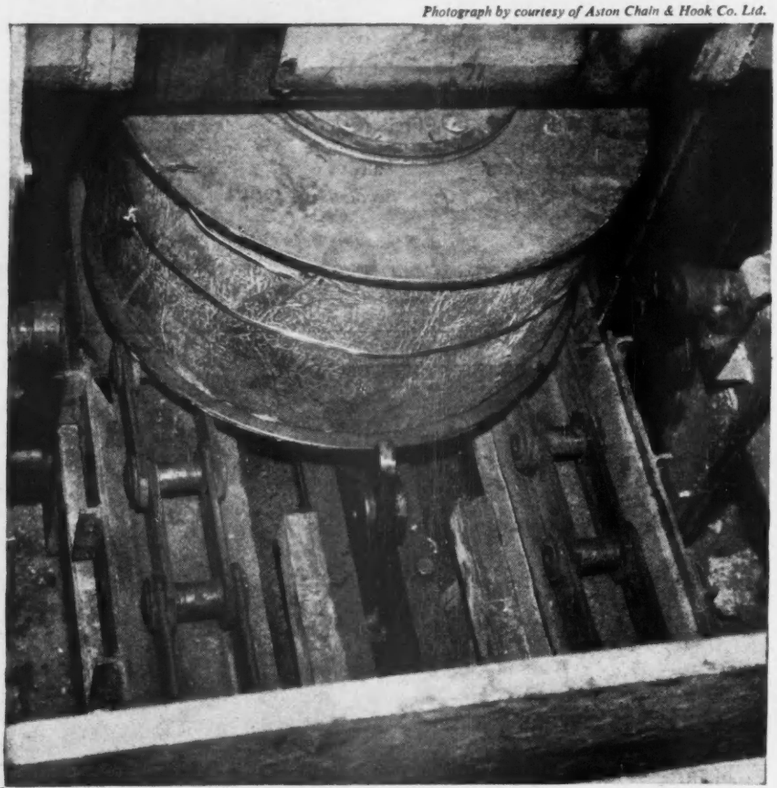

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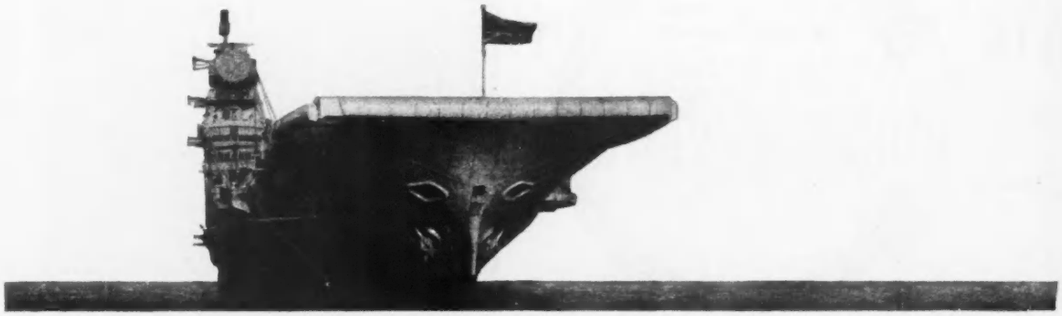

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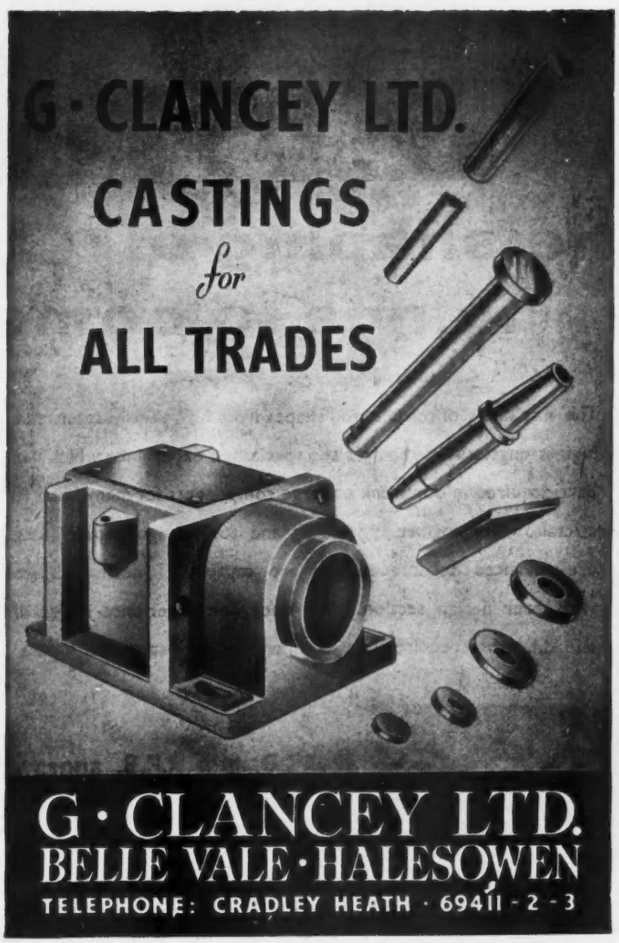

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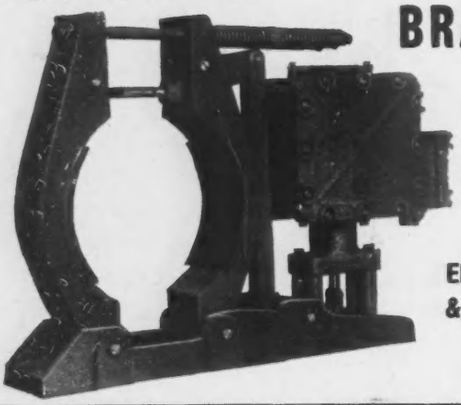

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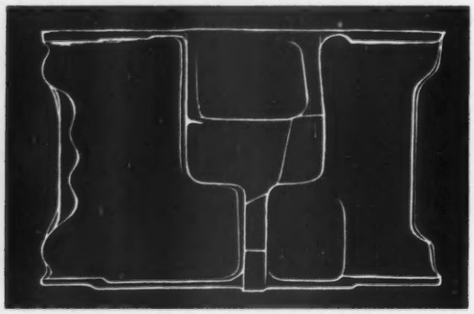

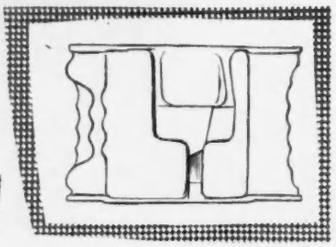

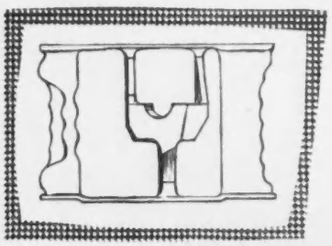

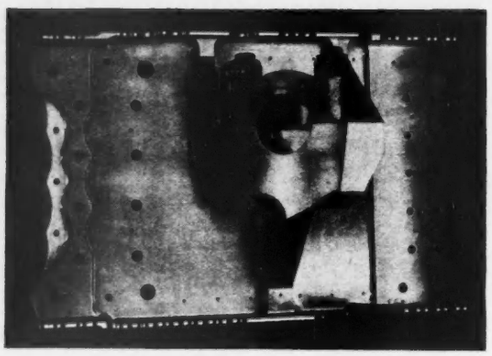

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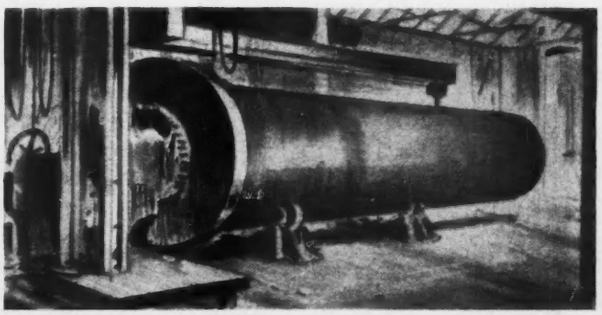

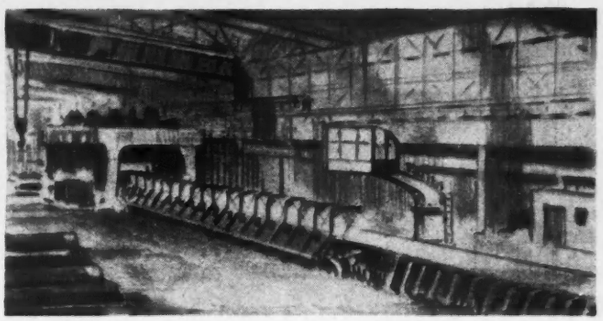

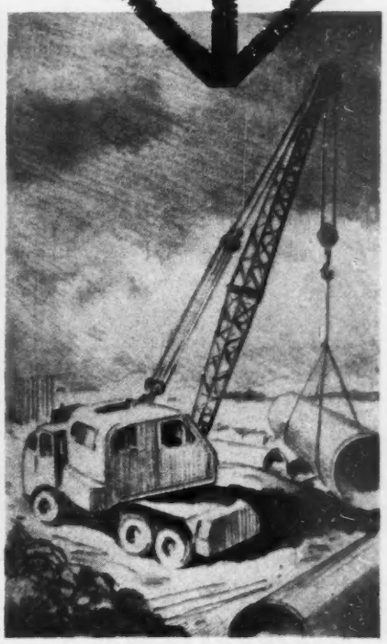

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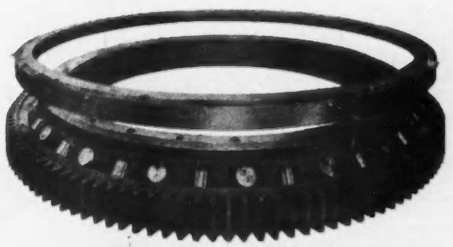

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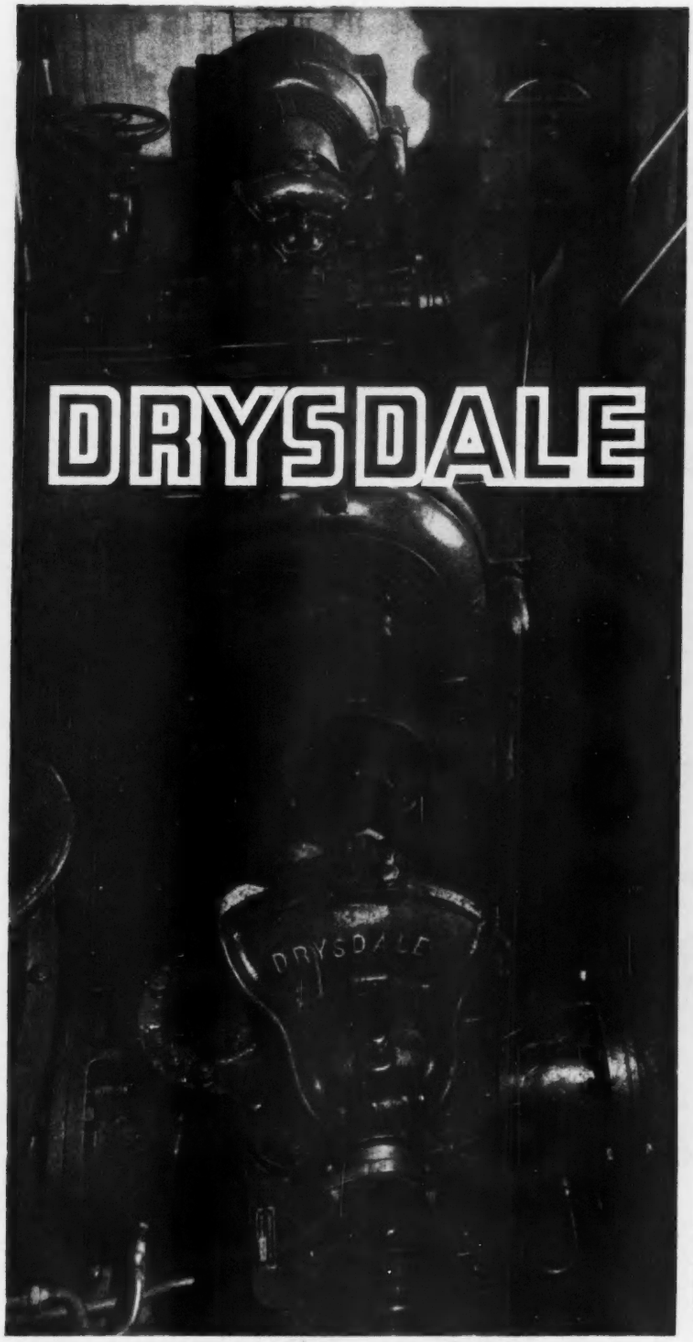

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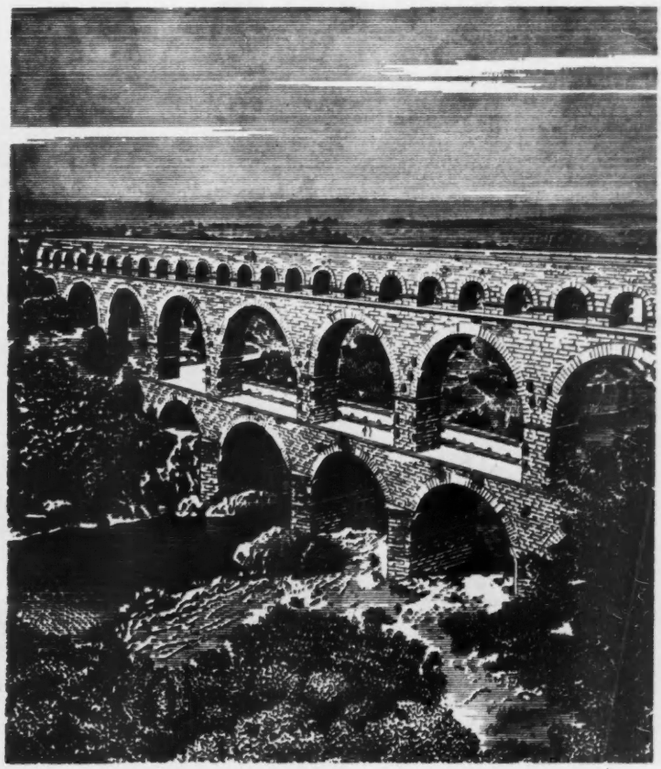

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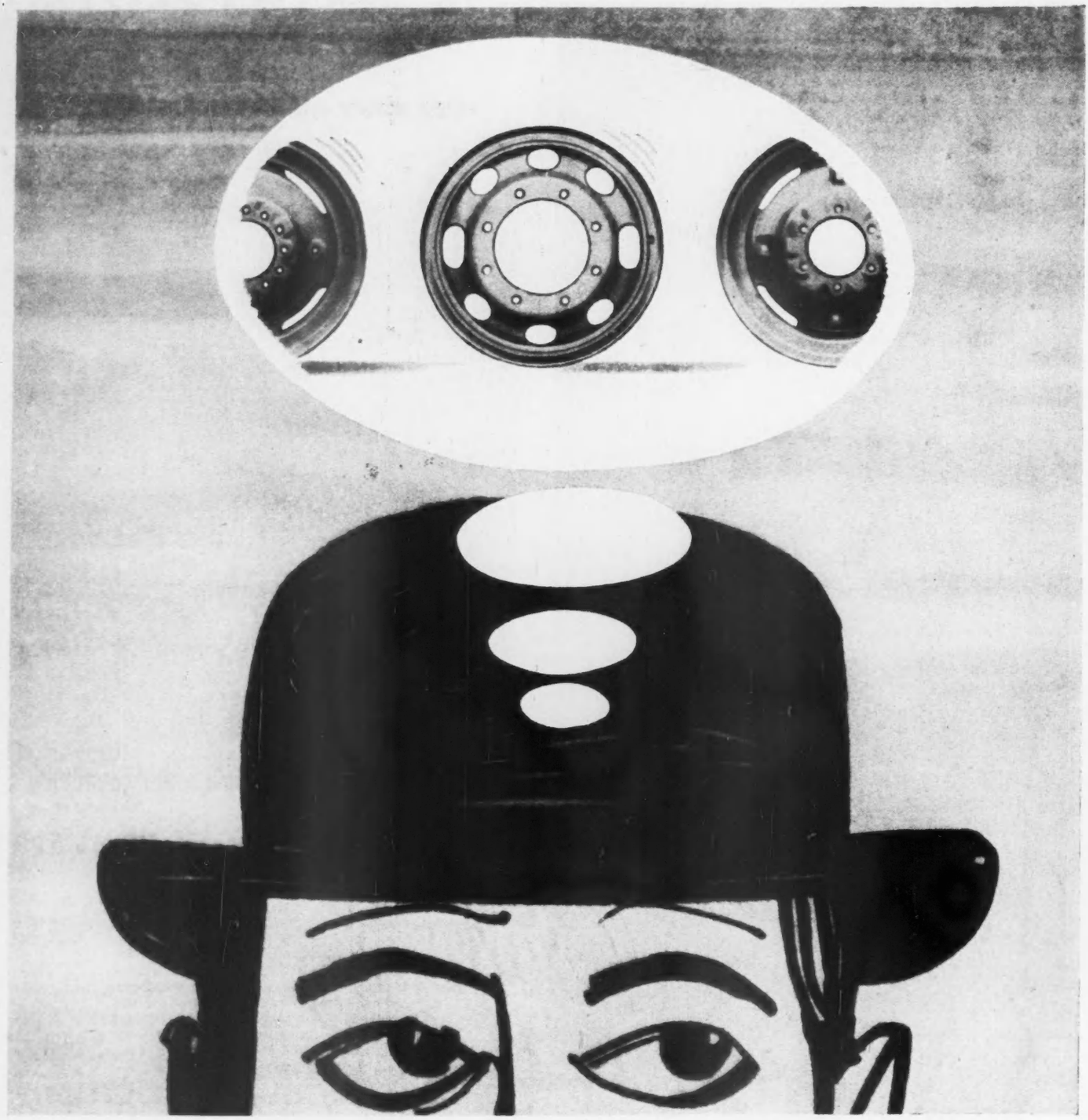

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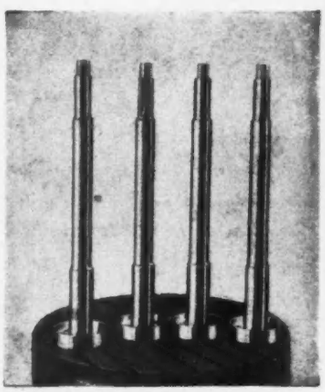
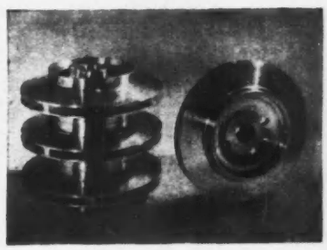
When a wear-resisting, wrought metal is required, 'K' Monel provides the strength and hardness needed for pump shafts, valve discs, or propeller shafts.

Erosion : The high resistance of 'S' Monel to erosion accounts for its extensive use in impellers, agitators and valve parts. In the most severe service, 'S' Monel gives three to ten times the life of ordinary materials when destructive erosion, abrasion and corrosion are involved.

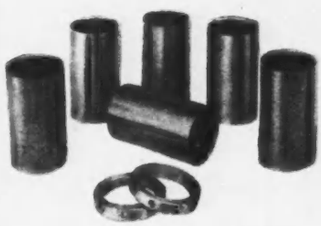
In resisting steam erosion, Monel and nickel are used at temperatures up to 425°C. and 'S' Monel up to 510°C.



'K' Monel shafts for salt water main circulation pumps in marine service.



Cast and machined Monel impellers are widely used in steam power and chemical plants.



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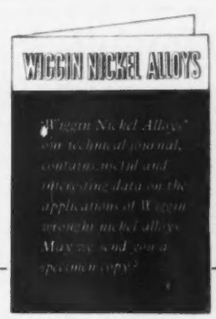
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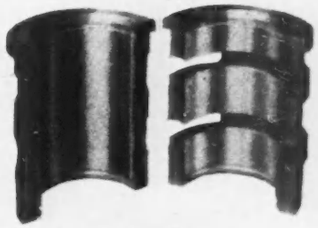

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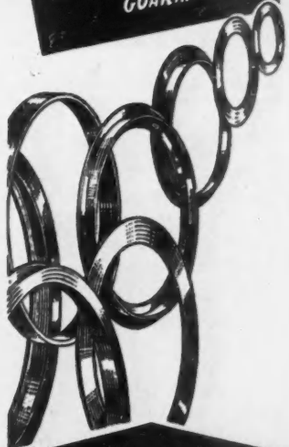

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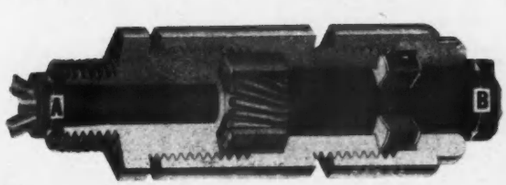
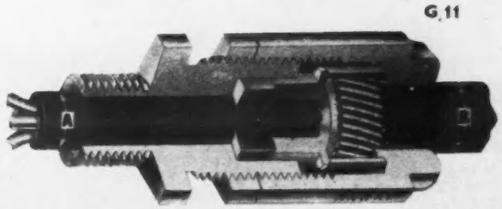


8/G3

G.11



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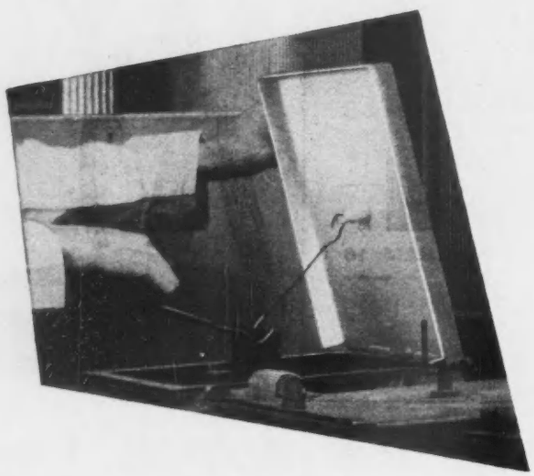

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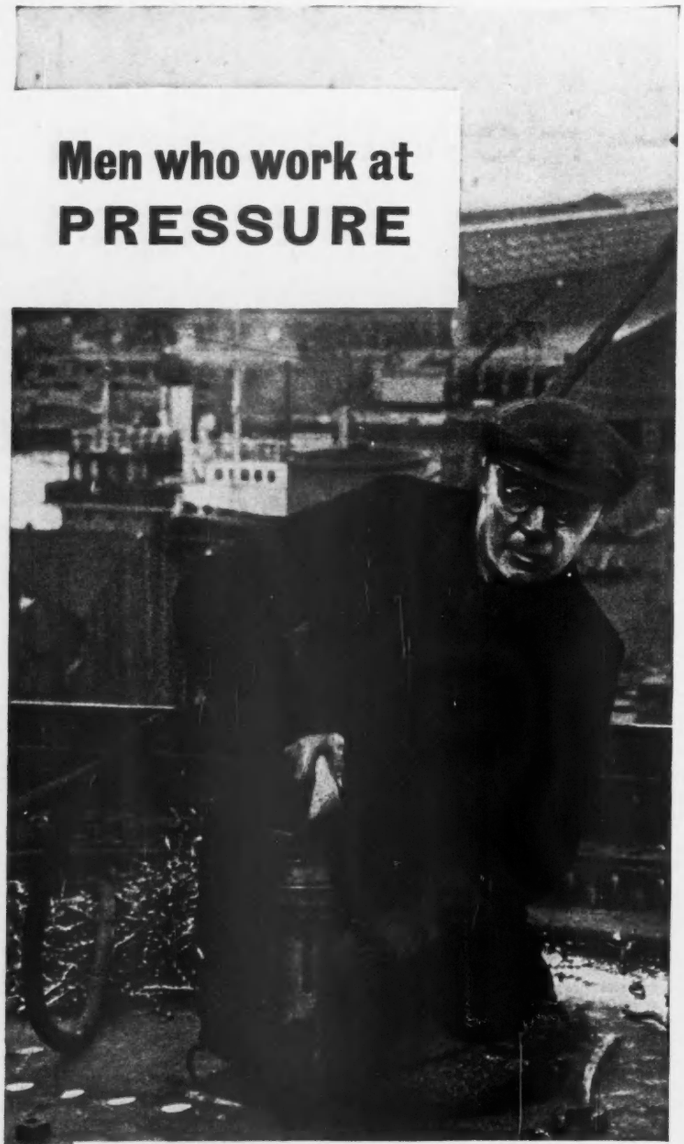

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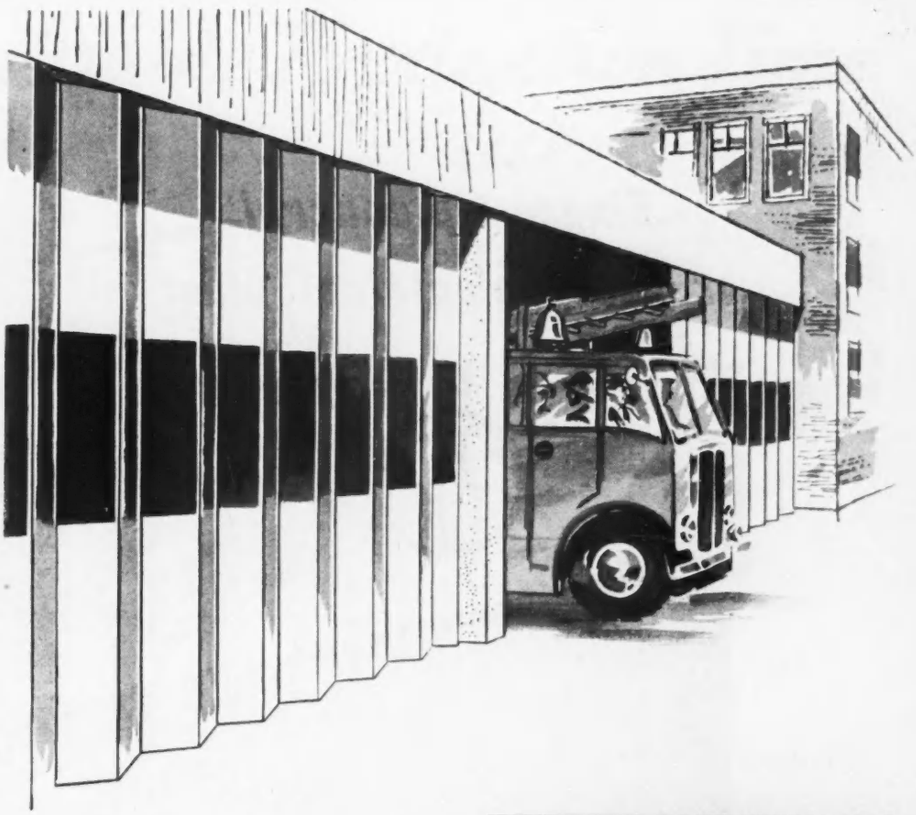

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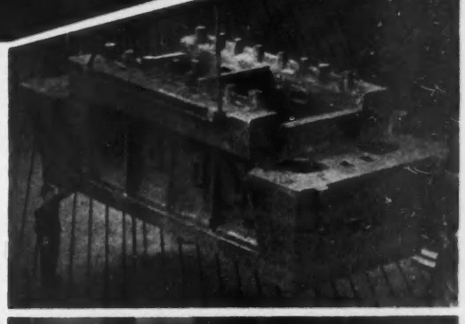

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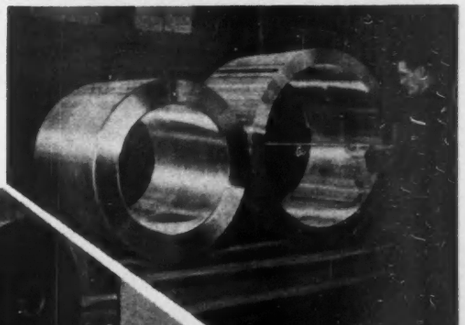

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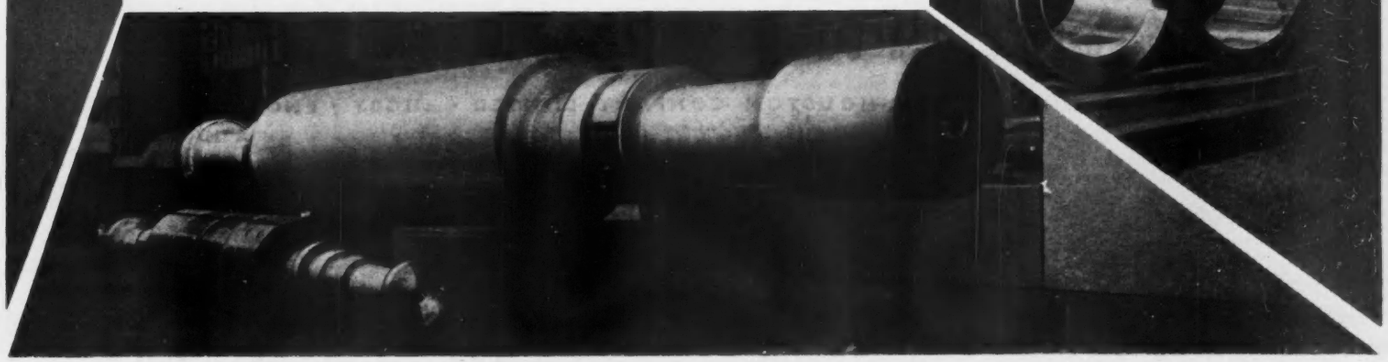

Finger-tip control of heavy electrical plant

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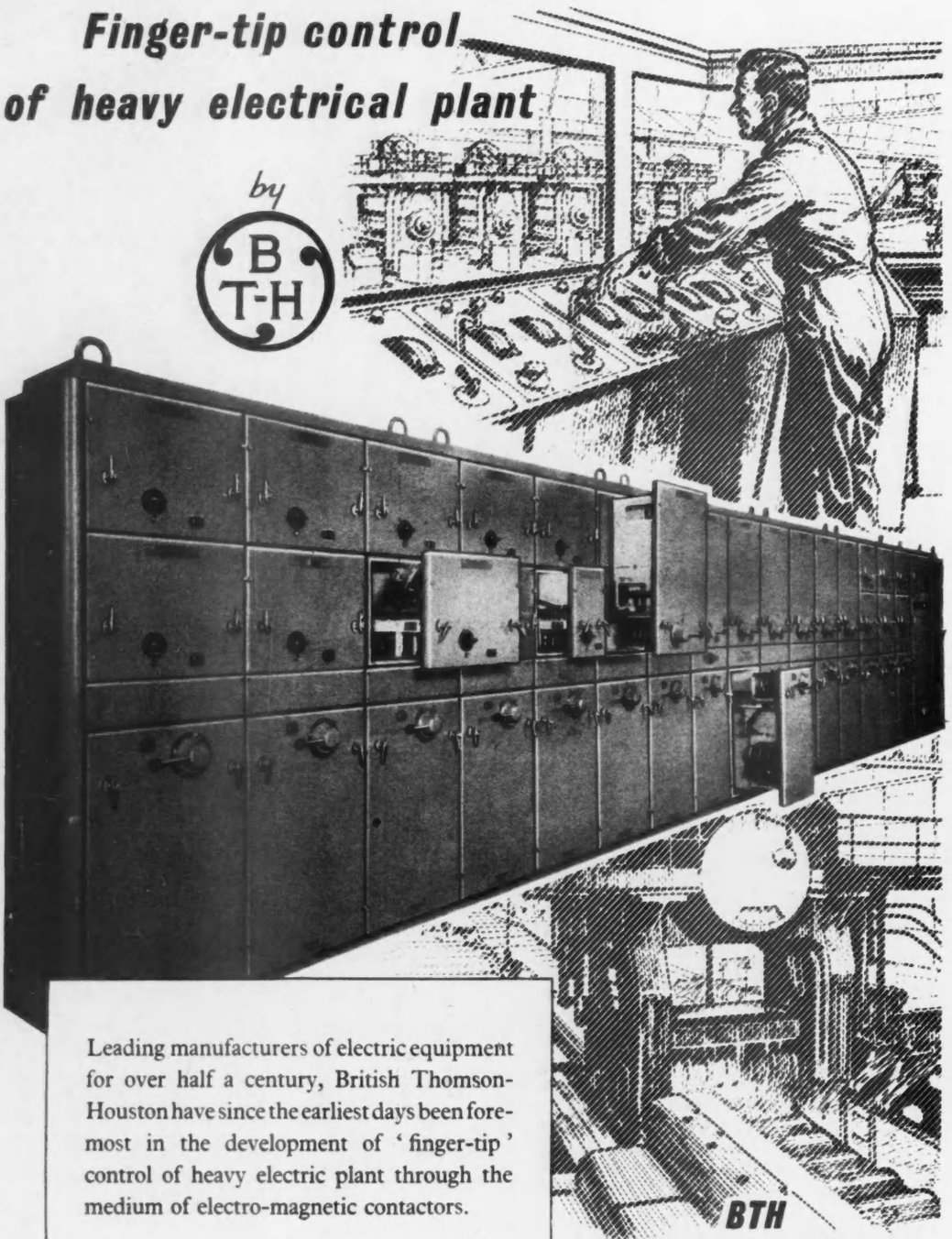

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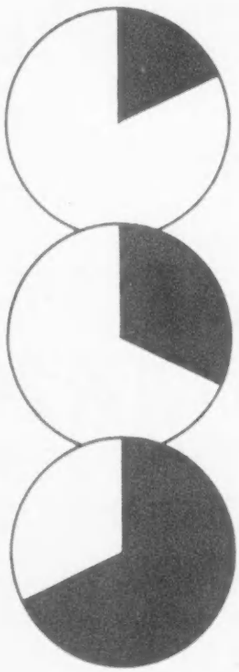

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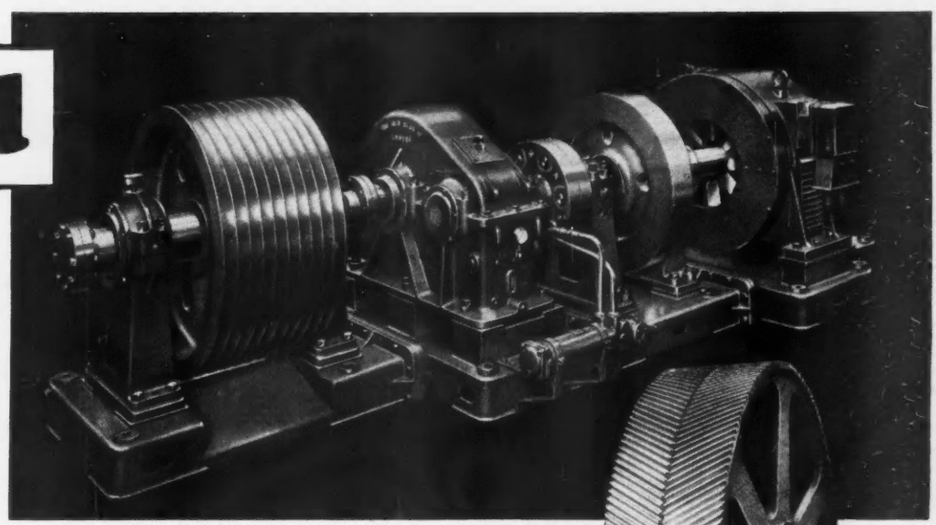

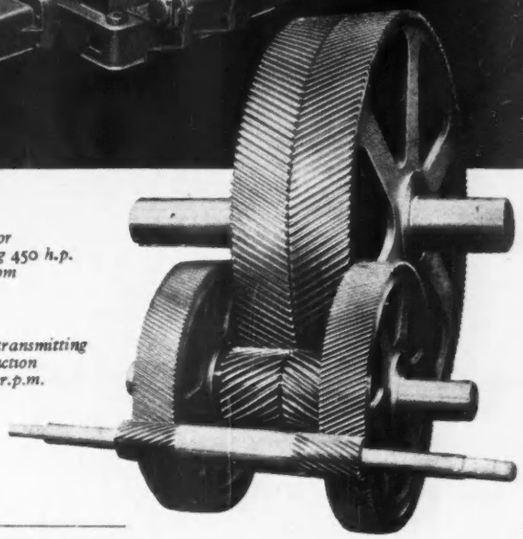

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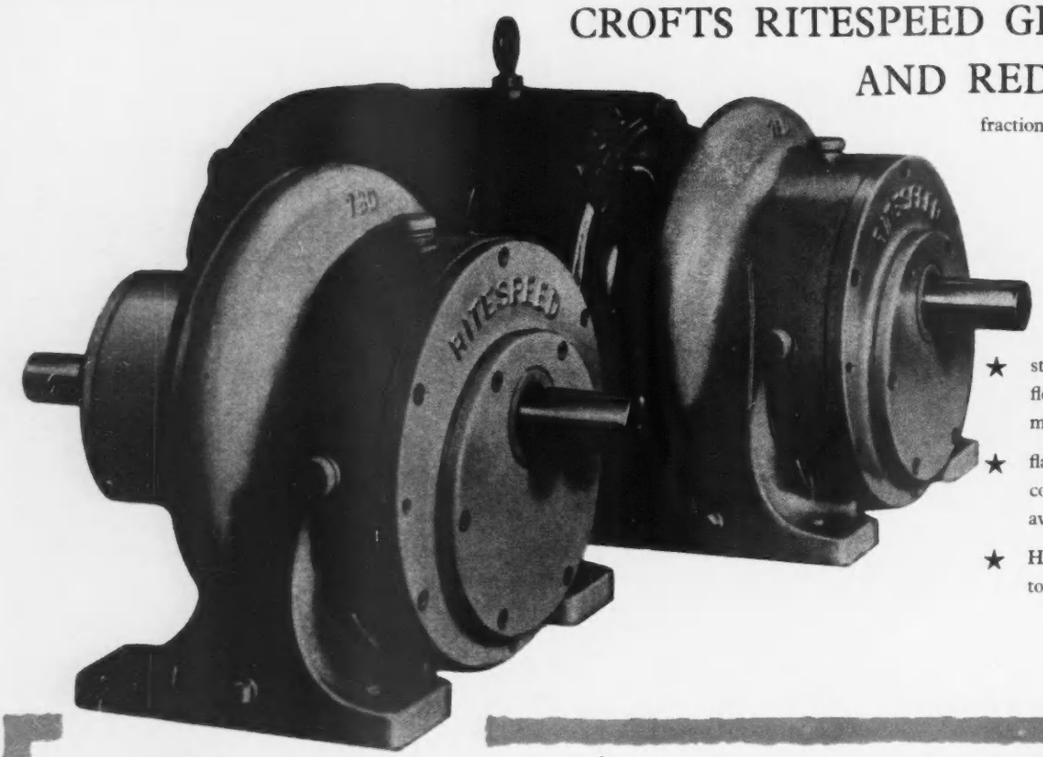

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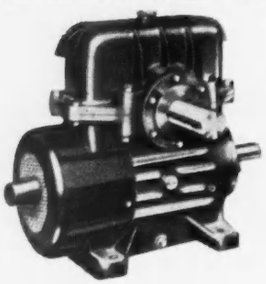

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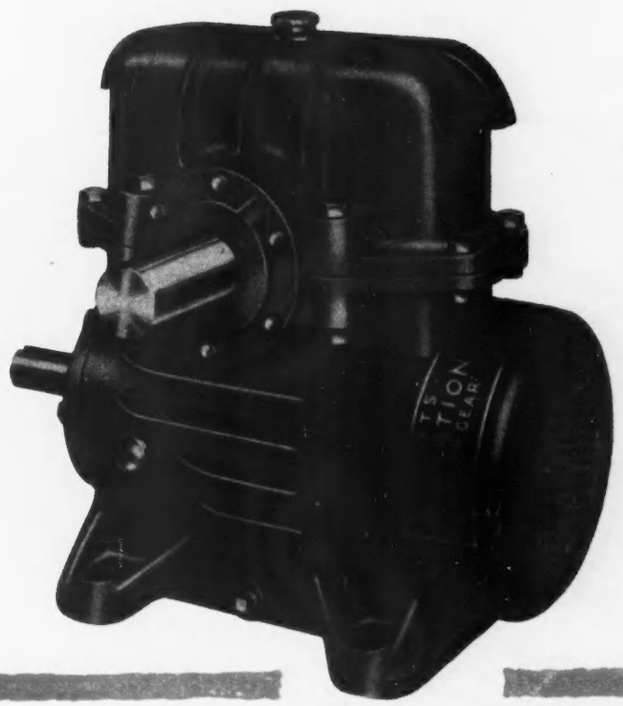

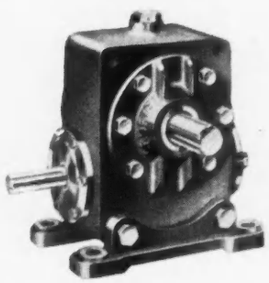

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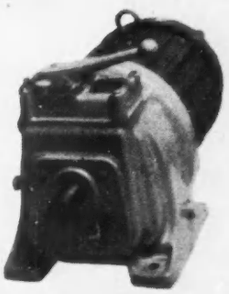

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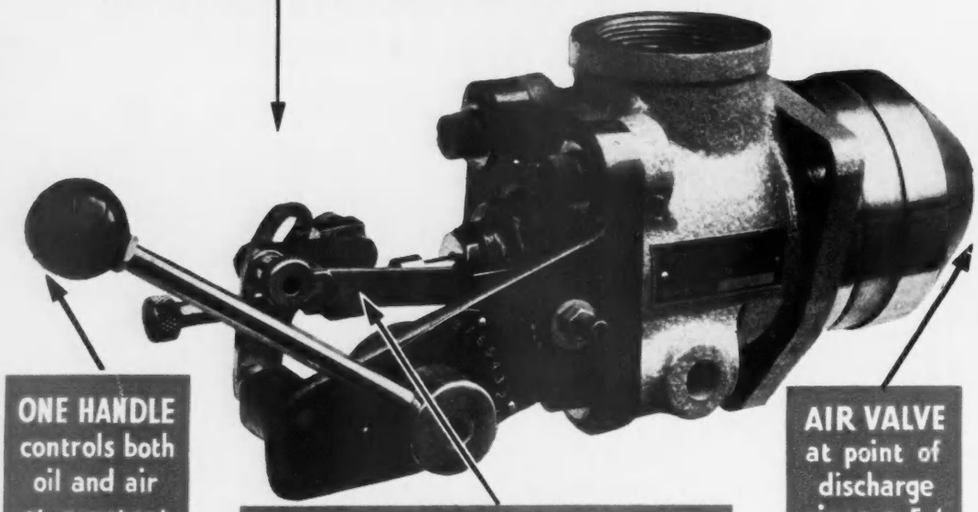

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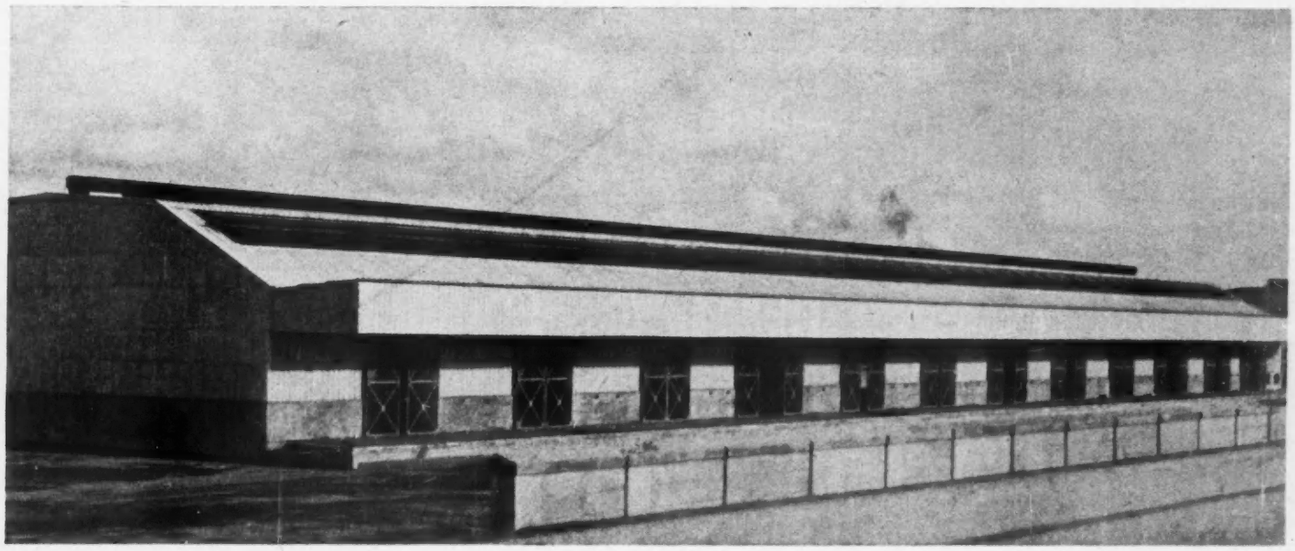

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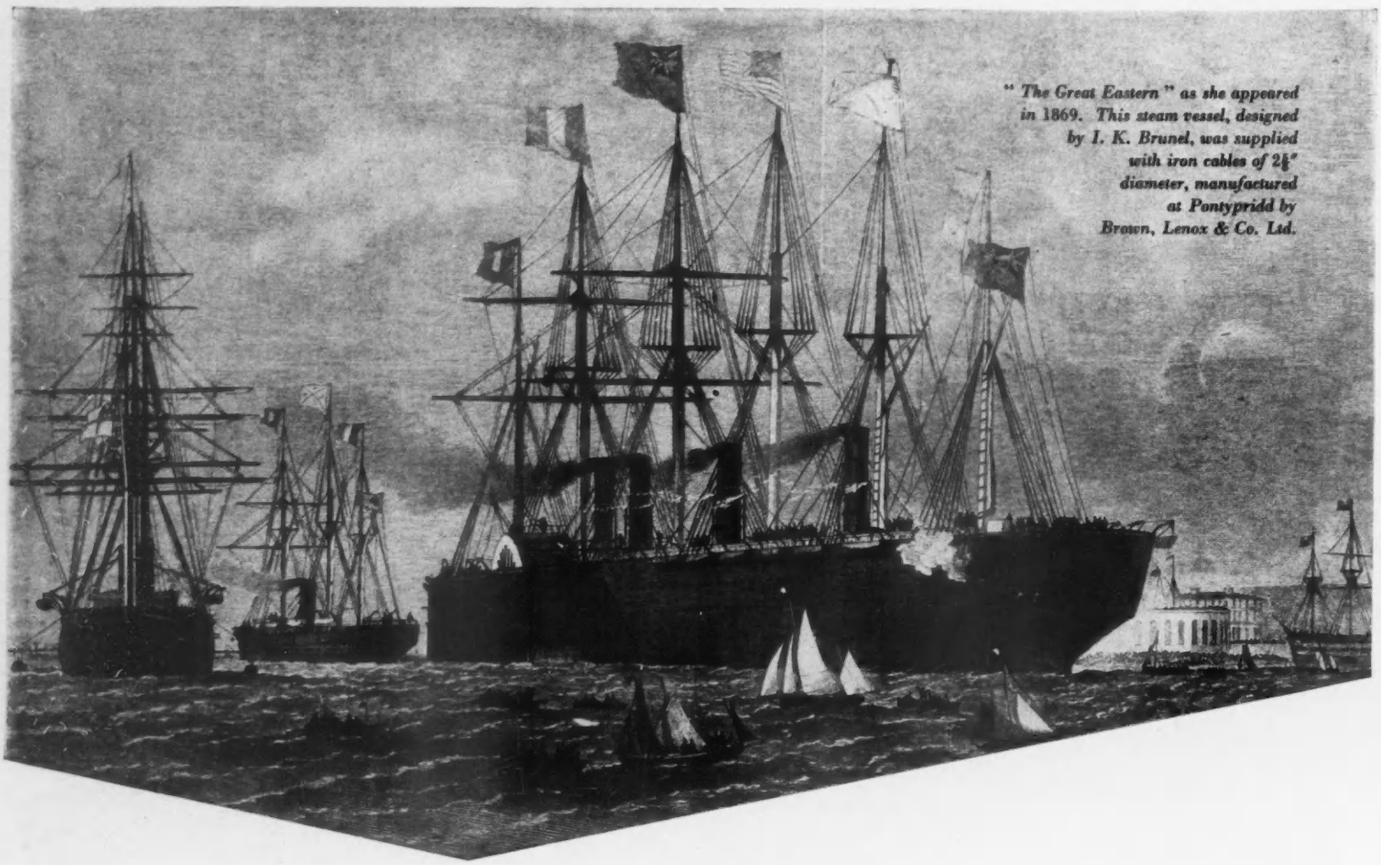

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- **SHIPS CHAINS, ANCHORS & ANCILLARY GEAR** (16 Pages)

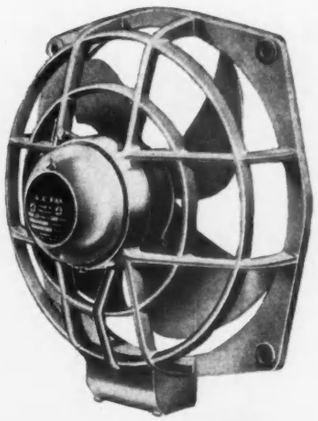
Copies of any, or all, of these publications will be sent free of charge, and postage paid.

Brown Lenox

Illustration by courtesy of the Trustees of the National Maritime Museum.

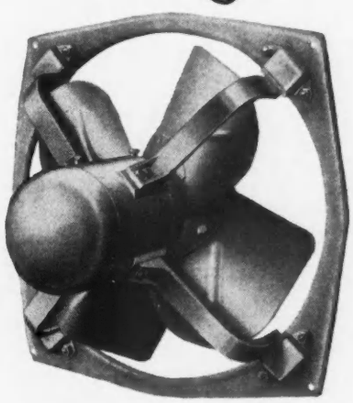
An announcement by the Marine Division of

BROWN, LENOX & COMPANY LIMITED
Associated Company: Brown, Lenox & Co. (London) Ltd., Millwall, E.14
PONTYPRIDD GLAMORGAN



Quality

costs less in the long run



The quality of engineering in WOODS propeller fans means lasting reliability and economy from long service. Remember, WOODS are the world's most widely used fans, chosen internationally for performance and quality.

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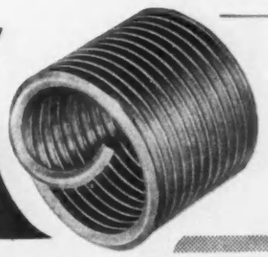
An associate company of The General Electric Co. Ltd. of England.

FAN ENGINEERS AT THE FOLLOWING BRANCHES: ABERDEEN, BELFAST, BIRMINGHAM, BRISTOL, CARDIFF, EDINBURGH, GLASGOW, LEEDS, LEICESTER, LIVERPOOL, LONDON, MANCHESTER, MIDDLESBROUGH, NEWCASTLE-ON-TYNE, NOTTINGHAM, SHEFFIELD.

Better than New with a . . . .



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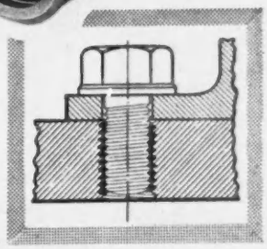
PRECISION MADE in CARBON STEEL for ALUMINIUM and MAGNESIUM.

We also make Stainless and Bronze for other applications.



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Tel: Combe Down 2355-8 **BATH, SOMERSET** *Grams: Circle, Bath*

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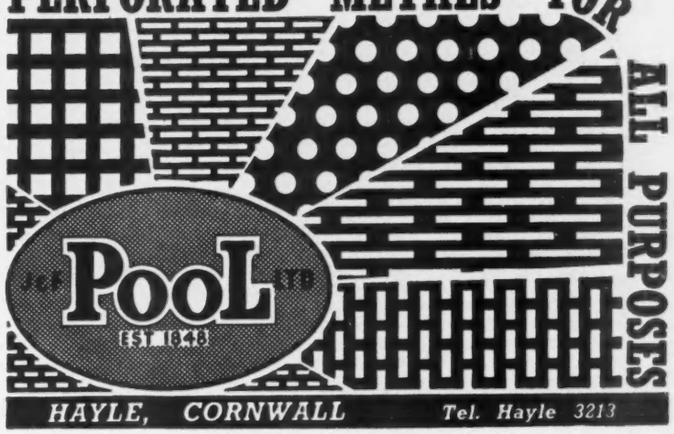

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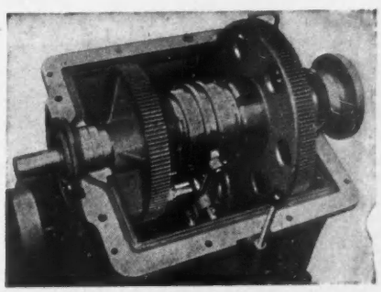
Powerful, Positive, Safe . . .

TAYLOR

Multiple Disc CLUTCHES



Resiliency, sensitivity, ease of control and the ability to perform continuous heavy duty without frequent adjustment, make Taylor Multiple Disc Clutches a popular choice for machine tool, plant, civil and heavy engineering. Such characteristics are ensured by:— Heat treatment and total enclosure of all operating parts; positive locking; single point adjustment and precision manufacture on modern plant. A Taylor Clutch is a self-contained unit, easily assembled, quickly fitted and produced to perform many years of strenuous work.

The illustrations show a typical application. The Reid Gear Co., Ltd., required a powerful, sensitive and completely trustworthy clutch unit for their two-speed reduction gear, to transmit the enormous effort applied in actuating the emergency sluice gate on a Scottish Hydro-Electric Project. The features mentioned above qualify Taylor Clutches to satisfy such exacting demands because they constitute the very ingredients of strength and reliability—the choice was a Taylor Multiple Disc Clutch.

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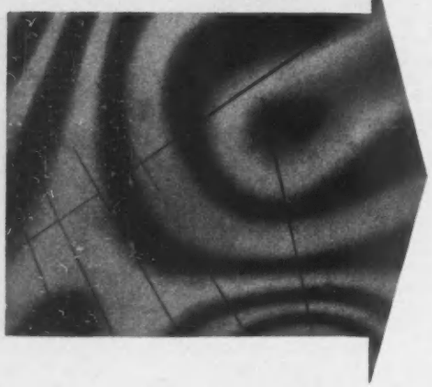
TROWS UPPER WORKS · CASTLETON · LANCS.

Tinsley



strain gauges

Electrical wire resistance strain gauges are accepted by engineers as one of the most important means of investigating stresses and strains in all types of structures and machines. The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

Tinsley strain gauges are available in various designs & materials to meet individual requirements within three broad temperature ranges:—

Standard strain gauges..... 70°C Max.
Medium temp. gauges..... 300°C Max.
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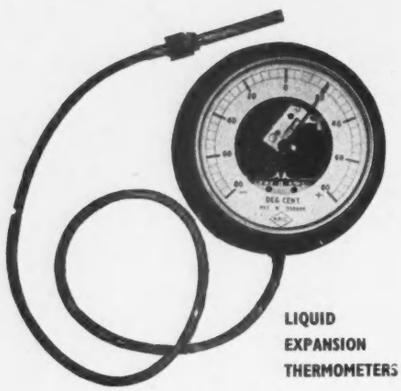
A range of measuring instruments can be supplied for indicating and recording static strains.

Write for Lists 210 and 210A, giving full particulars of Tinsley strain gauges and associated measuring apparatus.

H. TINSLEY & CO. LTD. WERNDEE HALL, SOUTH NORWOOD, LONDON S.E.25
Telephone: ADDiscombe 6046-7-8

ARIC instruments



LIQUID EXPANSION THERMOMETERS

Where accuracy over any suitable range between a temperature—240°F and 500°F (or centigrade equivalents) is required this fully compensated Thermometer is highly recommended.

Send for illustrated Catalogue of full range.

THE ACCURATE RECORDING INSTRUMENT CO., "ARIC" WORKS, WINDSOR AVENUE, MERTON, LONDON, S.W.19 PHONE: LIBERTY 5661-63

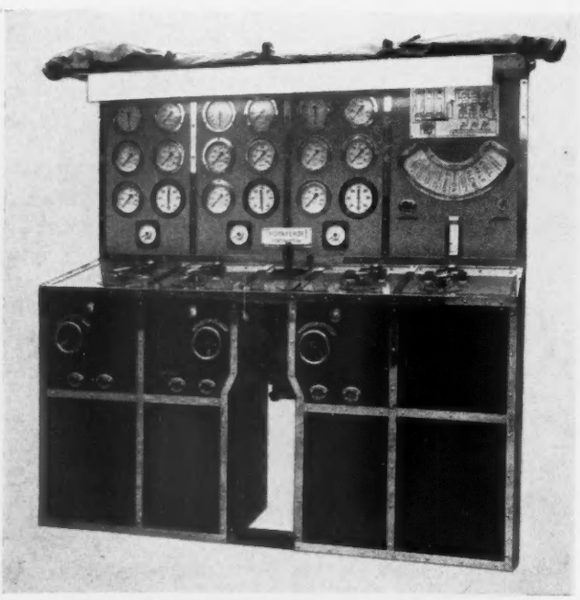
THORNYCROFT

OIL FUEL BURNING EQUIPMENT

The demand for Thornycroft Oil Fuel Burning Equipment for Marine installations continues to increase.

With over forty years of experience and the results of continuous experiment and research we are able to offer oil fuel burning equipment which is highly efficient, economical and safe, and like all Thornycroft productions, a good engineering job. Up to 3,500 seconds fuel oils can be burned cleanly and efficiently. Shown here is one of the Combustion Control panels which form part of the Thornycroft Oil Burning system in the *Queen Mary*.

For particulars of Marine equipment write for publication SEB.89A which includes a questionnaire for completion and return to us.



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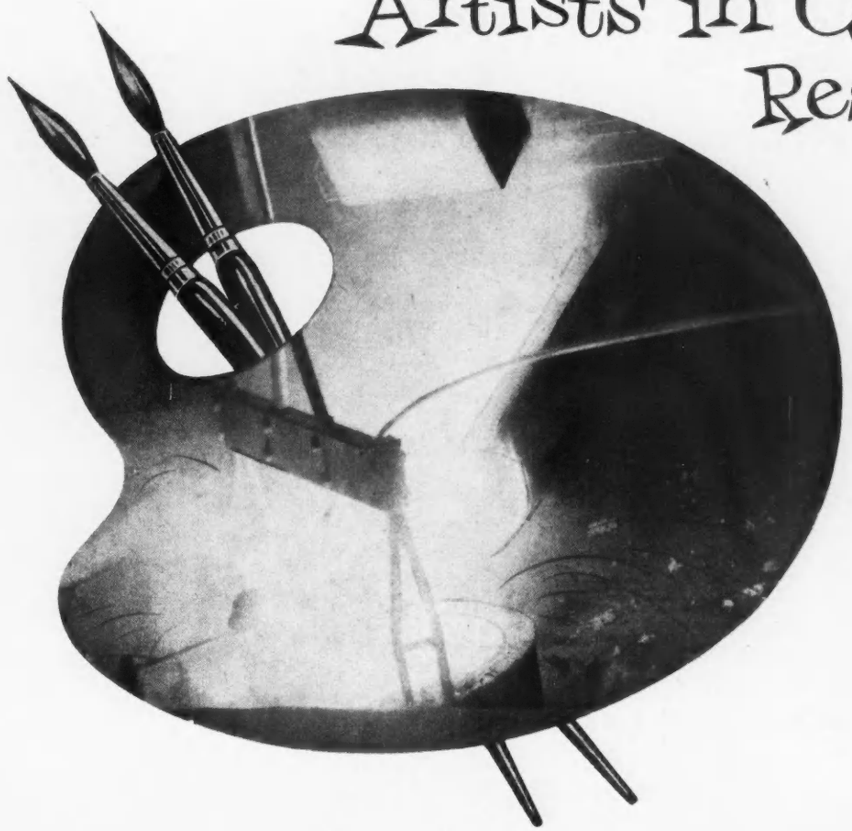

- ALLOY STEELS
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All castings can be machined in our modern machine shops

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LAKE & ELLIOT, LTD.,

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4 MILLION GALLONS per day

FROM THREE 30" DIAMETER OVERFLOWING BOREHOLES

For almost a century we have been constructing wells, and time has proved that they were well done.

It has always been our policy to give attention to detail and to visualise the end, with the intermediate snags, in order to bring the job to a successful conclusion.

Our knowledge of Water Engineering is old in years, but our outlook and approach are as new as tomorrow.

Let us tackle your Well job now and give you a well done job.

ISLER
ARTESIAN WELLS

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Telephone: WATerloo 7044

Branches: 93/4 BROAD STREET, BIRMINGHAM 15 Telephone: Midland 1762
BARDON CHAMBERS, KING ST., LEEDS 1 Telephone: Leeds 23550

KONTITE

The World's Finest Pipe Fittings

- All Kontite Castings are made in corrosion resisting gunmetal.
- The Kontite range of fittings is the largest in the trade.
- Our delivery service is second to none and all items can be delivered within a matter of days.
- Kontite Compression Fittings are made for all sizes of pipe up to 6" bore.

Free comprehensive catalogue will be supplied on request.

KAY & COMPANY (Engineers) LTD.
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HOWEVER SPECIAL YOUR REQUIREMENTS MAY BE ——— WE CAN SUPPLY FITTINGS FOR YOUR PURPOSE

PR

Rubber Components for the more Exacting Applications

Our wide experience in the field of precision rubber engineering qualifies us to advise on the rubber compounds and design of components to meet the more exacting applications.

Our plant is fully equipped to deal with bulk production, as well as small quantity requirements for prototype and development work.

Designers and Engineers will be interested in our new publication, 'Synthetic and Natural Rubbers and their Uses'-copy sent upon request.

High Grade Rubber Mouldings and Extrusions · 'O' Rings Seals · Bushes · Grommets · Diaphragms · Bonded Parts and Components in Natural, Synthetic and Silicone Rubbers

Typical examples of our production

APPROVED A.I.D. AND A.R.B.
PRECISION RUBBERS LIMITED · BAGWORTH · LEICESTER
Phone: BAGWORTH 241/2/3
Producers of Rubber Mouldings to fine dimensional tolerances and officially approved specifications

BALING PRESS *for* SCRAP METAL

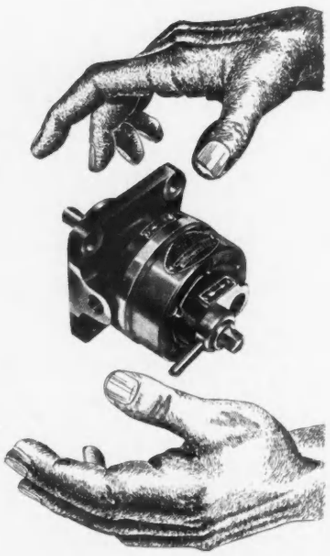
The **BEFASH 3**
A small metal Baling Press specially designed for handling TIN CANS, DRUMS, STAMPING WASTE, SWARF, NON-FERROUS SCRAP, WIRE, etc.
Write for Leaflet 1013

Note these outstanding features—

★ **ALL ELECTRIC OPERATION**
★ **PUSH BUTTON CONTROL**
★ **NO FOUNDATIONS**

Planters

THE PLANTERS ENGINEERING CO. LTD.
14, Craven Road, London, W.2. Tel: AMBassador 3295/6. Cables: Veloces, Padd, London
Associated with ENTWISLE & GASS LTD.



More accurate than human skill itself----------

Hydraulic Control of motion

Paradoxically, the product of human skill is more accurate than human skill itself. This is particularly so in the case of Savery Hydraulic Pumps. Countless thousands of Savery Pumps are in use throughout the world working with precision that neither human skill nor other means can match. Next time you're considering control of motion remember Savery Hydraulic Pumps first. Savery Pumps can be supplied with fixed or variable delivery.

FOR FURTHER DETAILS OF

SAVERY HYDRAULIC PUMPS

WRITE TO

THOMAS SAVERY PUMPS LIMITED

BRACEBRIDGE STREET, BIRMINGHAM 6 : Telephone: ASTon Cross 1316-7

THE MODERN EASY WORKING LIGHT-WEIGHT GEARED BALL BEARING SCREW LIFTING JACK TYPE B.B. 140. CAPACITIES 15-75 TONS

Write for list B.B.2/1

YOUNGS (LIFTING APPLIANCES) LTD

RYLAND STREET WORKS, BIRMINGHAM 16. Tel: EDGbaston 3508-9 Grams: 'OLDENS, B'HAM.'

A COMPLETE RANGE OF

'Micronic' OIL FILTERS

Purolator Micronic oil filters provide complete protection for your engine. By removing even the smallest particles of harmful dirt, they drastically reduce the rate of engine wear.

The construction of the 'Micronic' element ensures that the largest possible filtering area is packed into the available space, thus providing longer life.

A relief valve allows the oil to continue flowing if the element is allowed to become completely choked.

Both external pipe and direct pad mounting types (as illustrated) are available for all sizes of engine.

AUTOMOTIVE PRODUCTS COMPANY LIMITED

LEAMINGTON SPA, WARWICKSHIRE

Regd. Trade Marks: 'PUROLATOR' 'MICRONIC'

PUROLATOR

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch.
There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

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There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-on and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

***Advertisements for publication should be addressed to*:—Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

MINISTRY OF LABOUR AND NATIONAL SERVICE

UNESCO

PROFESSOR OF HYDRAULICS—INDIA

Applications are invited for an appointment under UNESCO's Programme of Technical Assistance to underdeveloped countries, as PROFESSOR OF HYDRAULICS, DAM CONSTRUCTION AND IRRIGATION at the Poona Engineering College, India. Will be required to teach hydraulics and dam construction to post-graduates for M.Sc. Degree and also to set up a new Hydraulics Laboratory, for which a building has been prepared and the equipment ordered. Must have a higher Degree in Civil Engineering with Hydraulics as the main subject. Specialised knowledge of soil mechanics, water power engineering and hydraulics as applied to design and construction of dams and both University teaching and practical experience on dam projects essential. Should also have done some original research. Duration one year, with possibility of renewal for further two years. Salary £3125 per annum, plus generous allowances (minimum £600 per annum; family allowances in addition), all tax-free. Free return passages for appointee, wife and dependent children.

For further information and application forms, write to Ministry of Labour and National Service (E.9), 26–28, King Street, London, S.W.1, quoting E9/UNE/351/IND. E9422

COUNTY BOROUGH OF BOURNEMOUTH

MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURER

LECTURER required in the Mechanical Engineering Department, to teach Mechanical Engineering subjects to the standard of the A2 year of the Higher National Certificate and of Part II London B.Sc. (Eng.).

Applicants should have a Degree or equivalent qualification and teaching experience.

Salary in accordance with the Burnham Technical Scale, 1956: Lecturer, £1200 by £30 to £1350.

Further particulars and application forms obtainable from W. R. Smedley, Chief Education Officer, Town Hall, Bournemouth. E9420

UNIVERSITY OF LEEDS

DEPARTMENT OF ELECTRICAL ENGINEERING

LECTURER

Applications are invited for appointment as LECTURER or ASSISTANT LECTURER in the Department of Electrical Engineering; duties will include teaching and research in microwave engineering. Salary on scale £900 by £50 to £1350 (efficiency bar) by £75 to £1650 a year for a Lecturer, or within range £700–£850 a year for an Assistant Lecturer, according to age, qualifications and experience.

Applications (three copies), stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained), not later than 12th January, 1959. E9409

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF CIVIL ENGINEERING

SENIOR RESEARCH ASSISTANT

Honours Graduates in Engineering are invited to apply for appointment as SENIOR RESEARCH ASSISTANT for work on a research contract involving some soil mechanics. Candidates may read for Higher Degrees. Lecturers' salary scale £900 by £50 to £1300, with membership of Universities Superannuation Scheme and family allowances.—Conditions of appointment and form of application, which should be returned by 10th January, 1959, from The Registrar. E9445

UNIVERSITY OF MANCHESTER

CHAIR OF NUCLEAR ENGINEERING

Applications are invited for the CHAIR OF NUCLEAR ENGINEERING which has been instituted in the Department of Engineering of the Faculty of Science. Salary not less than £2300 per annum. Membership of the F.S.S.U. and Children's Allowance Scheme.—Applications (one copy only) should be sent not later than January 1st, 1959, to the Registrar, the University, Manchester, 13, from whom further particulars may be obtained. E9284

CITY OF SHEFFIELD

WATERWORKS DEPARTMENT

SENIOR TECHNICAL ASSISTANT

Appointment of SENIOR TECHNICAL ASSISTANT.

Applications are invited for the above appointment (Special Classes Grade, £910 by £40 to £1030) on the permanent staff of the Waterworks General Manager and Engineer (J. Noel Wood, M.I.C.E.). Commencing salary £910 or £950, according to qualifications, ability and experience.

Applicants must be University Graduates or have passed Parts I and II of the examination of the Institution of Civil Engineers and in each case to have had at least five years' experience (including the period spent on theoretical training).

The post is superannuable and the successful applicant will be required to pass a medical examination.

Housing accommodation available if required.

Applications, stating age, education and training, qualifications, present and past appointments (with dates and salaries), and quoting the names and addresses of two referees, should reach the undersigned not later than the 17th January, 1959.

JOHN HEYS,
Town Clerk.

Town Hall,
Sheffield, 1. E9417

MINISTRY OF SUPPLY

ARMAMENT RESEARCH AND DEVELOPMENT ESTABLISHMENT

APPOINTMENTS

Armament Research and Development Establishment, Fort Halstead, Sevenoaks, Kent, requires PHYSICISTS, ELECTRONIC, ELECTRICAL and MECHANICAL ENGINEERS, for work on guided weapons and fire control systems; PHYSICAL CHEMISTS for explosives phenomenology; METALLURGISTS for problems in physical metallurgy. Appointments in Grade (a) SENIOR SCIENTIFIC OFFICER (minimum age 26, at least 3 years' post graduate research experience), or (b) SCIENTIFIC OFFICER, 1st or 2nd Hons. Degree or equivalent. Salary ranges: (a) £1130–£1330; (b) £595–£1050 (male, in provinces). Rates for women same by 1961. Superannuation under F.S.S.U. Opportunity for those under 31 to compete for pensionable posts. Candidates should indicate fields of work in which interested.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A454/8A). E9421

COUNTY BOROUGH OF BRIGHTON

WATERWORKS DEPARTMENT

CHIEF ASSISTANT ENGINEER

CHIEF ASSISTANT ENGINEER, Grade A.P.T. V (£1175 by £50 to £1325).

Good experience required in general Waterworks construction, and must hold University Degree in Civil Engineering and/or Corporate Membership of either the Institution of Civil, Mechanical or Municipal Engineers. The appointment is superannuable, terminable by one month's notice on either side and subject to medical examination; 50 per cent. of removal expenses refunded.

Application forms from Waterworks Engineer, 12, Bond Street, Brighton, 1, to be returned to him suitably endorsed by 31st December, 1958.

W. O. DODD,
Town Clerk.

Town Hall,
Brighton, 1.
6th December, 1958. E9418

NATIONAL COAL BOARD

DURHAM DIVISION

AREA CENTRAL WORKSHOPS MANAGERS

Applications are invited for the above posts in Nos. 2 and 4 Areas of the Division. The workshops of the former are near Houghton-le-Spring, and of the latter at Tursdale, near Ferryhill.

The No. 2 Area appointment will carry a salary of up to £1750; that in No. 4 Area will be within the range £1050/£1600. The starting salaries will be in accordance with the qualifications and experience of the successful candidates.

The number of men employed in the No, 2 Area workshops is about 600, and in No. 4 Area, 400. The works are engaged mainly on the overhaul and repair of electrical and mechanical coal mining plant and machinery.

Candidates should have a general engineering background and preferably have some knowledge and experience of mining plant and equipment. They must be conversant with the repair of wagons to main line standard. Experience in the heavy repair of steam and diesel locomotives is essential for the No. 2 Area post and desirable for that in No. 4 Area. Candidates for No. 2 Area must have a knowledge of iron and brass foundry technique. Both posts require persons capable of supervising the overall working and administration of the shops to achieve and sustain the maximum throughout of planned overhaul and jobbing work and of maintaining the required standards of workmanship and good personal relationships. The possession of a Higher National Certificate in Mechanical and/or Electrical Engineering or equivalent is essential.

Applicants should reply within 7 days, quoting SG/290/3(78) for No. 2 Area, and SG/290/4(78) for No. 4 Area (submitting separate applications for each vacancy if they are competing for both), and giving full details of age, education, qualifications and experience to N.C.B., 7, Side, Newcastle upon Tyne, 1. E9429

CITY OF CARDIFF CORPORATION WATERWORKS

LLANDEGFEDD WATER SCHEME

APPOINTMENTS

Applications are invited from suitably qualified persons for the following temporary appointments (superannuable) in connection with the proposed Llandegfedd Water Scheme of the Corporation.

(a) RESIDENT ENGINEER, to take charge of design and construction work under the Consulting Engineer for river intake works, large pumping plant, large diameter mains and treatment plant dealing with 15/20 million gallons of water per day. Candidates must be Corporate Members of the Institution of Civil Engineers and have had considerable experience in charge of similar works. The commencing salary of the appointment will be £1750 per annum, and the Engineer appointed will be required to reside near the site in a house to be provided by the Corporation.

(b) JUNIOR ASSISTANT ENGINEER, to work under the Resident Engineer. Candidates must either be Corporate Members of the Institution of Civil Engineers or have qualifications exempting them from Sections "A" and "B" of the Associate Membership examination. The commencing salary will be £750 per annum.

Further information and conditions of service concerning these appointments may be obtained from the Water Engineer, City Hall, Cardiff. Applications, together with the names of two referees, should reach the undersigned in envelopes appropriately endorsed not later than Monday, 12th January, 1959.

S. TAPPER-JONES,
Town Clerk.

City Hall,
Cardiff,
December, 1958. E9434

CIVIL SERVICE COMMISSION

CIVIL ENGINEERS

Pensionable posts for men and women aged 25 and under 35 on January 1st, 1958; extension for regular Forces service, Overseas Civil Service, established Civil Service, and temporary Government service as Civil Engineer. Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining Corporate Membership. Men's starting salary from £755 to £1085. Maximum (London) £1250. Promotion prospects.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S64/58. E9412

NATIONAL RESEARCH COUNCIL, OTTAWA, CANADA

RESEARCH POSITIONS

The National Research Council of Canada, Ottawa, Division of Building Research, has RESEARCH POSITIONS offering unusual opportunities for the development of fundamental studies in relatively new fields. These include field and laboratory studies of heat and moisture transfer processes in the ground; investigation of combined heat conduction and moisture movement in building materials. Well-equipped heat and moisture transfer laboratories are available.

Education required: Honour Bachelor or Master Degree in Physics, Engineering Physics, or Mechanical Engineering. Knowledge of mathematics of diffusion and experience in heat transfer analysis are desirable.

Salary will depend on qualifications.

Please reply, giving full details, to the Employment Officer, National Research Council, Sussex Drive, Ottawa, 2, Canada.

Please quote BR–219. E9451

ATOMIC WEAPONS RESEARCH ESTABLISHMENT

ALDERMASTON, BERKS

ENGINEER (MAIN GRADE)

ENGINEER (Main Grade) required by the Atomic Weapons Research Establishment, Aldermaston, Berks. To be responsible for the engineering design of electronic and electro-mechanical equipment to suit production and Services requirements on the basis of information supplied by the Research and Development Laboratories. To arrange for the issue of information to contractors and inspectorates and advise them in the early stages of production.

A recognised engineering apprenticeship and either A.M.I.E.E. or A.M.I.Mech.E., or equivalent qualifications, are required. Previous experience in this class of work is desirable.

Salary: £1300–£1740.

Contributory superannuation scheme. A house or, alternatively, substantial assistance with house purchase, will become available for married officers living beyond daily travelling distance.

Postcards for application forms to the Senior Recruitment Officer at above address. Please quote ref. 2101/25. E9410

SOUTH WARWICKSHIRE HOSPITAL GROUP

STRATFORD-ON-AVON HOSPITAL

SENIOR ENGINEER

SENIOR ENGINEER (non-resident) required (beds—163 hospital and 80 Part III). Will also supervise services at nearby Monroe Devis Maternity Home (24 beds) and Children's (Recovery) Hospital (40 beds). Salary scale £655 by (5) £25 to £780. Responsible to Superintendent Engineer for maintenance of engineering equipment and buildings. Should hold Second Class Certificate of Competence (M.O.T.) or approved equivalent; have served a recognised apprenticeship; sound experience in maintenance and operation of steam boiler plant, electrical equipment, heating and hot water supplies and control of staff.—Applications, with three referees, to Group Secretary, 50, Holly Walk, Leamington Spa, 10 days after appearance of this advertisement. E9438

NATIONAL RESEARCH COUNCIL, OTTAWA, CANADA

The National Research Council of Canada, Ottawa, Division of Building Research, offers OUTSTANDING OPPORTUNITIES for research into aspects of heating and air-conditioning, including (1) the investigation of heat and moisture flow and air leakage in building components, such as walls, windows and roofs; (2) investigations on the thermal performance of chimneys as a basis for improved standards. Extensive large scale laboratory facilities are available.

Education required: Bachelor Degree with honour standing in Mechanical Engineering.

Salary will depend on qualifications.

Please reply, giving full details, to the Employment Officer, National Research Council, Sussex Drive, Ottawa, 2, Canada.

Please quote BR–218. E9452

PUBLIC APPOINTMENTS

ASSISTANT DESIGN ENGINEERS

are required by the Atomic Energy Authority in its design offices at Risley, Warrington, to undertake individual design work of a high standard or to lead small teams of draughtsmen, and to give assistance at sites during construction and commissioning.

(a) NUCLEAR CHEMICAL PLANT AND FUEL ELEMENT PLANTS—

design and specification of both conventional and radioactive chemical plants and laboratories involving the use of chemical engineering techniques; design of equipment for casting, heat treatment, remote handling, welding and automatic control problems requiring special materials. (Ref. 2803/J.1.)

(b) MECHANICAL POWER SERVICES—

design and specification of boiler and compressor plant and associated pipework; installation of diesel engines. (Ref. 2804/J.1.)

(c) REACTOR DESIGN—

design of nuclear reactors involving power plant layout, boilers and heat exchangers, steam and feed water plant, mechanical handling, instrumentation, centrifugal or axial fans, variable speed drives, centrifugal pumps, pressure vessels, heating and ventilation, machine tool and general machine design. (Ref. 2805/J.1.)

(d) ELECTRICAL ENGINEERING—

layout of E.H.T. systems; specification of switchgear and cabling, and large and small rotating machines; H.T. and L.T. factory distribution. (Ref. 2806/J.1.)

(e) INSTRUMENTS—

design and application of measurement and control systems in the field of industrial instrumentation as applied to extensive chemical plants and unique processes for the treatment of radioactive materials, and to prototype and testing reactors. (Ref. 2807/J.1.)

Salary for these posts between

£880 and £1270

Applicants must have served a recognised engineering apprenticeship and possess at least an H.N.C. or equivalent in an appropriate subject. Comparable training in lieu of apprenticeship will be accepted for Instruments posts. Good design experience in one or more of the fields outlined is essential, whilst graduate membership of a senior engineering institution would be an advantage.

DRAUGHTSMEN

are also required on the above projects, which provide opportunities to gain experience and promotion on interesting and vital work in connection with the development of nuclear energy. (Ref. 2808/J.1.)

Salary for these posts between

£555 (at age 21) and £865

Applicants must possess an O.N.C. or equivalent in an appropriate subject and have at least three years' workshop experience. Drawing office experience in one or more of the fields outlined is desirable.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form, quoting appropriate reference, to:

Recruitment Officer,
UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
INDUSTRIAL GROUP HEADQUARTERS,
RISLEY, WARRINGTON, LANCASHIRE.

E9426

PUBLIC APPOINTMENTS

COMMONWEALTH OF AUSTRALIA.
AUSTRALIAN DEFENCE SCIENTIFIC SERVICE.

ENGINEERS FOR ROCKET DEVELOPMENT

Applications are invited for positions of EXPERIMENTAL OFFICER, GRADE 1, at Weapons Research Establishment, near Adelaide, South Australia.

SALARY:
£966/£1416 (Australian Currency).

DUTIES:
Associated with a group responsible for the design, development and launching of special purpose rocket propelled vehicles.

QUALIFICATIONS:
Degree or Diploma in Mechanical, Electro-mechanical or Aeronautical Engineering fields.
Applications from persons who expect to obtain the required qualification by the end of the present academic year will be considered.

Whilst the positions are classified as temporary, the tenure of employment is not limited and after a specific period, appointees will be able to apply for entry to the Commonwealth Superannuation scheme.
First-class Sea/Air fare for the appointee and dependents (wife and dependent children) will be paid under specified conditions by the Commonwealth.
Assistance will be given in obtaining housing accommodation. Application forms obtainable from:

Senior Representative (A.V.12/8),
Department of Supply,
Australia House,
Strand,
London, W.C.2,

with whom applications should be lodged by 19th January, 1959.

E9443

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A MAINTENANCE ENGINEER is required for the London area by a well-known group of companies. He must be an experienced and qualified engineer (30–40) and will be responsible for preparation of preventive maintenance schedules, supervision and control of engineering services and maintenance of building, plant and machinery. The salary is in accordance with qualifications and experience. Apply, giving full details of age, qualifications and experience.—BOX No. E9427, "The Engineer."

ALFRED HOLT AND CO.
THE BLUE FUNNEL LINE
Invite applications for the position of
SUPERINTENDENT ENGINEER
New Construction

The successful candidate will assume responsibility under the Chief Superintendent Engineer for the engineering aspects of ships building and projected including calculations, specifications, layout, building progress and trials.
Candidates must have considerable previous marine engineering experience and qualifications equivalent to an Honours Degree in Mechanical Engineering, or an extra First Class M.O.T. Certificate. Applicants between the ages of 30–38 will be preferred. The appointment is at the Company's Head Office in Liverpool, and residence in that area will be necessary.
Applications, which will be treated in confidence, should be accompanied by two names for reference purposes. Suitable candidates will be asked to attend a preliminary interview at Liverpool when terms and conditions of employment will be discussed.
Applications should be addressed to ALFRED HOLT AND CO., INDIA BUILDINGS, LIVERPOOL 2, marked "Superintendent Engineer."

E9371 A

BEECHAM OVERSEAS, LTD., have a vacancy for an EXECUTIVE ENGINEER in the Development section at their headquarters in West London. The successful applicant should have a recognised qualification in either mechanical, plant, production or chemical engineering. The position is an interesting and attractive one covering a wide field of technical development in connection with buildings, plant layout and plant installations relative to the production of medicinal, toilet and beverage products overseas. Applicants should be between the age group 25–35 and be prepared to increase their technical know edge by further study and if necessary by attending classes approved by the company.—Apply in writing only, giving full details of age, qualifications and experience to the Personnel Controller, Beecham Group, Ltd., Beecham House, Great West Road, Brentford, Middlesex. E9379 A

Classified Advts. continued on page 118

TENDERS

INDIA STORE DEPARTMENT

SCREW THREAD GAUGES AND SETTING PLUGS

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of:
SCREW THREAD GAUGES AND SETTING PLUGS for Unified and British Standard Threads of Various Sizes, Types and Grades—1666 Nos.
Please quote reference No. 17528/GNK/HAL.
The Tender forms with schedules and specifications which are returnable on Thursday, 15th January, 1959, may be obtained from the above office (C.D.N. Branch) on payment of a fee (which is not refundable) of ten shillings for each Tender.—Applications for Tenders should clearly state the reference numbers of the tenders required. E9419

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

EDUCATIONAL

RESEARCH FELLOWSHIP AT THE ROAD RESEARCH LABORATORY, HARMONDSWORTH, MIDDLESEX

SPONSORED BY
THE REES JEFFREYS ROAD FUND

The Rees Jeffreys Road Fund invite applications for a FELLOWSHIP tenable at the Traffic and Safety Division of the Road Research Laboratory, Harmondsworth, Middlesex, for a period of two years. The Fellow would be required to work on the following project:

"To study either (a) the effect of layout of roads on vehicle operating costs, or (b) to study road traffic in selected New Towns."

Candidates should hold a 1st or 2nd Class Honours Degree or an approved qualification in economics, physics or engineering. The grant associated with the Fellowship would be about £2000 to cover a two-year period (inclusive of subsistence, travelling, &c.) according to circumstances.

Closing date: 19th January, 1959.

Applications should be addressed to: Director of Road Research, Road Research Laboratory, Harmondsworth, Middlesex. E9424 E

COMPANY MEETING

HEENAN GROUP LIMITED

MR. CHARLES HILL'S REVIEW OF ACTIVITIES

The 56th annual general meeting of Heenan Group, Limited, was held on December 15th at Worcester Engineering Works, Worcester, Mr. Charles L. Hill, the Chairman, presiding.

The following is an extract from his circulated statement:—

The Group net profit, before taxation, of £419,481, compares with £496,062 last year. After deducting taxation of £250,167 against £274,199, the net profit of the Group is £169,314, which compares with £221,845 in 1957.

Against a background of less buoyant conditions and strong competition for the available business in the export markets, the overall intake of orders by the Group Companies during the year was well maintained, ending with a balance of £4,500,000 compared with £5,000,000 at the start of the year. There has, however, been a marked falling off in new orders, the downward trend starting in June 1958 with the low point being reached in the first month of the current financial year, since when there has been some improvement.

Due to the orders in hand, the level of output of the Group factories for the first nine months of the current financial year is not expected to show any appreciable fall, but activity in the last few months will depend upon improvement in the rate of new orders.

Falling profit margins in the last few years have been largely the result of increasing costs which have been offset by the benefits arising from capacity production, but more recently profits have been subjected to the pressure of severe competition, particularly in the overseas markets. The lower profits for the year are, in fact, the result of a fall in profit margins and do not reflect a falling off in activity during the year. Unless we are able to make other economies in working costs, these profit margins will be further affected by the recent national wage increase in the engineering trades which cannot be recovered by higher prices if we are to keep out trade in the export markets.

SUBSIDIARY COMPANIES' ACTIVITIES

Turning to a brief review of the operations of the subsidiary companies—**Heenan and Froude, Limited.** Having regard to the high total of sales in the Engine Test Plant Section in the past ten years, the demand for special plant has kept up extremely well.

The Eddy-Current Coupling Section again recorded a substantial increase in sales, including quantity orders for conveyor applications in the motor and rayon trades.

The Electronic Engineering Section slightly improved upon the previous year's record deliveries of electronic equipment.

In the Industrial Cooler Section sales were maintained at the level of the previous year. The Heenan-Marley Cooling Towers are selling well and have proved a valuable addition to the range.

There has been a fall in the demand for Automatic Wire and Strip Forming Machines.

Orders received by the Municipal Engineering Division were up on the previous year and a number of contracts for plant are currently under negotiation. The sale of industrial and municipal incinerators in both the Heenan and Horsfall ranges have again increased.

Fielding and Platt, Limited, at the year end, had a balance of orders in excess of the previous year. This, however, does not fully represent to-day's position as some of the orders booked are for long-term delivery.

As is usual in this Company, the year's output covered a large variety of hydraulic equipment, including a number of heavy Extrusion Presses, equipment for the Admiralty, the Atomic Energy Authority, the Ministry of Works and the National Coal Board. In spite of the work done for these Ministries, the main bulk of the output has been for private enterprise companies at home and abroad, and during the year hydraulic presses have been despatched to countries as far apart as Canada, Russia, Australia and South Africa.

Development is continuing in connection with the cold extrusion of metals, particularly with the Company's patented "Hypactor" Press, a number of which are working with successful and interesting results. Your directors believe there is a great future in this field.

The sales value of Malleable Iron and Grey Iron castings produced by **Court Works, Limited,** was well maintained at around the previous year's level, but the intense competition in the foundry trade has forced down prices with a consequent fall in the rate of profit.

As in previous years, half the production of **W. G. Bagnall, Limited,** was exported and half the orders received came from overseas. There is a continuing demand for this subsidiary's Diesel shunting locomotives. The order book value at the close of the year was slightly higher than at the same time last year.

Morton Machine Co., Limited, experienced another satisfactory year's trading. In the mixing machinery field the Air Pressure Whisk, for long a favourite on the home market, was the subject of a sales drive in the U.S.A. As a result the U.S.A. has now become the major country of over twenty foreign markets steadily importing the Company's products. The volume of sales of dry powder precision mixers and machinery for the chemical industry greatly increased and an order received in the year for a film casting machine was the largest single contract ever received by the Company.

IWEL Engineering, Limited, has traded at a satisfactory level and earned good profits in relation to its capital. Reduced sales in the U.K. have been fully compensated by increased export activity and substantial contracts have been completed in the Sudan and in Nigeria. This subsidiary's future prosperity will continue to depend largely on export sales, and new markets are being actively sought.

Associated Locomotive Equipment, Limited, had a highly successful year, a record profit having been achieved. In spite of the changeover in the form of railway motive power affecting demand for the Company's products, a reasonable order book remains. Intensive efforts are continuing with development work on a specialised line of particular interest for Group manufacture.

The report was adopted.

SITUATIONS VACANT

A SENIOR ENGINEER, aged about 30–35, with several years' experience of the aerodynamic design and testing of compressors and turbines, required for the Power Jets' Consultancy Department at Farnborough, Hants. A responsible position covering a wide field of interest is offered. Good salary and superannuation. Excellent working conditions.—Fullest details in confidence to the Secretary, POWER JETS (R. and D.), LTD., 25, Green Street, London, W.1. E9405 A

ASSISTANT ENGINEER required by British Timber Company operating in the Far East for maintenance of heavy crawler tractors, wheeled vehicles, excavators and general logging plant. Soundly educated young man aged about 21, having completed apprenticeship as agricultural or automotive engineer preferred, but previous experience of maintenance outlined above not essential. Good commencing salary and superannuation scheme; accommodation and heavy furniture provided, together with passage and arrangements for leave on full salary.—Full particulars of training and experience to BOX No. T.2083/2, c/o Foster Turner and Everetts, Ltd., 11, Old Jewry, London, E.C.2. E9411 A

ASSISTANT PLANT INSPECTOR
BAHRAIN PETROLEUM COMPANY, LIMITED

APPLICATIONS are invited for this position from men with a Degree in Engineering, Metallurgy or Physics who have had a minimum of two years' experience in the design, construction, or maintenance of unfired pressure vessels, including a year on their inspection in service. Candidates should be familiar with A.P.I., A.S.M.E. codes applicable to Petroleum Liquids and Gases, since the duties include inspection and gauging on vessels, exchangers, pumps, lines, valves, &c., in those services.

The commencing salary is £1332 per annum, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid local and home leaves are also provided.—Apply in writing, with full particulars, to Caltex Services, Limited, Caltex House, Knightsbridge Green, London, S.W.1, quoting "INS." E9397 A

CHIEF DRAUGHTSMAN

Company manufacturing rolling mills and other steelworks machinery require first-class man. Only those with the necessary technical qualifications and experience in the control of a drawing-office need apply. Full details, including age, to be stated.—BOX No. E9336, "The Engineer." A

CHIEF JIG AND TOOL DRAUGHTSMAN.—Firm manufacturing medium/heavy machinery requires the services of a Chief Jig and Tool Draughtsman, to take charge of a small drawing-office. Age 30–35. Applicants should state details of education, training, experience and salary required.—Applications to Personnel Manager, RUSTON-BUCYRUS, LTD., Excavator Works, Lincoln. E9447 A

CIVIL, CHEMICAL,
ELECTRICAL
and
MECHANICAL ENGINEERS

CALTEX SERVICES, LTD. invite applications for these positions from qualified engineers under 35 with design experience which should preferably have been connected with oil refineries providing their own power. The positions are initially in London, but applicants should be prepared for overseas assignment later, the salary being commensurate with qualifications and experience.

Apply in writing quoting reference "LON" to CALTEX SERVICES, LTD., Caltex House, Knightsbridge Green, London, S.W.1. E9423 A

DESIGNER - DRAUGHTSMAN required for development department of a large industrial concern in the Midlands. This work will include a wide range of plant design, development of prototype machines, factory planning and layout, progressing installation programmes and study of machine operations efficiency. Good prospects of promotion.—Applications are invited from persons holding at least H.N.C. in Mechanical Engineering or equivalent, stating qualifications, experience and present salary, to the Personnel Manager, BOX No. E9440, "The Engineer." A

DESIGNER-DRAUGHTSMAN (MECHANICAL) required for research and development team engaged on interesting development work in connection with special structures and diesel and steam-operated plant. Minimum qualifications H.N.C. Age group 24–30 years. The appointment is permanent and progressive in an expanding organisation. Contributory pension scheme and good canteen facilities. Salary in accordance with age, qualifications and experience. The works are situated 15 (fifteen) minutes' bus journey from the centre of Ipswich.—Applications to Personnel Officer, THE BRITISH STEEL PILING CO., LTD., Claydon, Suffolk. E9335 A

DRAUGHTSMAN-DESIGNER in Structural Steelwork required for London Office dealing with wide range of interesting work on industrial and commercial buildings of many types. Good knowledge of standard practice and code requirements essential; knowledge of reinforced concrete, foundations and general building work a distinct advantage. Five-day week; superannuation scheme; permanent position to right man with prospects of promotion.—Apply, giving details of age and experience to Personnel Division (GOS/394), UNILEVER, LTD., Unilever House, Blackfriars, London, E.C.4. E9416 A

ENGINEERING SALES REPRESENTATIVE required for Midlands area, preferably resident between Birmingham and Manchester. Qualifications A.M.I.Mech.E. or equivalent standard. Design experience of mechanical handling plant for coal, coke and quarried materials essential. Age 32–45 years. State salary required. SOUTHERN AREA REPRESENTATIVE also required, with similar qualifications. Resident London–Reading district.—Robert Cort & Son, Ltd., Reading (ref. WLR). E2209 A

ENGINEER SURVEYOR required for inspection of Boiler and Pressure Plant. Must have 1st Class M.O.T. Certificate with Steam Endorsement or equivalent. Salary £735 to £1060 (ESA Scale), other benefits. Staffordshire and East Lancs. area.—Apply Engineering Dept., GENERAL ASSURANCE CORP., LTD., 99, Aldwych, W.C.2. E9433 A

ENGINEER SURVEYORS required for inspection of cranes and other lifting plant. Must have drawing-office experience of design of cranes, also National Certificate for Mechanical Engineering. South London or Monmouth and S. Wales. Salary £735 to £1060 (ESA scale). Non-contributory pension. Apply Eng. Dept., GENERAL ACCIDENT CORP., LTD., 99, Aldwych, W.C.2. E9436 A

EXPERIENCED DESIGN DRAUGHTSMEN (MECHANICAL) required by BRITISH NYLON SPINNERS, LTD. Applications are invited from Mechanical Draughtsmen who have had at least five years' drawing-office experience. Candidates should preferably possess a H.N.C. or Grad. I.Mech.E. These are permanent, pensionable appointments and offer good opportunities for progress to capable and well-qualified candidates. The company is sited in pleasant and rural surroundings about three miles from Pontypool. Unfurnished houses are available to rent in the area, and generous assistance is given towards the cost of the move to this area.—Reply in writing to Personnel Manager, Pontypool, Mon. E9437 A

INSTRUMENT ENGINEERS
COURTAULDS, LIMITED
ENGINEERING DIVISION,
COVENTRY

Applications are invited from INSTRUMENT ENGINEERS with plant experience and suitable technical qualifications to enable them to fit into positions at Engineering Headquarters, working on instrumentation schemes for a wide range of industrial processes.

Other vacancies are available in factories for the installation and maintenance of instrumentation equipment.

Applications will be welcomed from suitable qualified people who wish to make a career in automatic control engineering in its widest sense.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Ltd., 16, St. Martins-le-Grand, London, E.C.1, quoting reference number B.51. E9358 A

MAINTENANCE ENGINEER (35–40), good electrical knowledge.—Mark Anthony and Sons, Ltd., Chalk Hill, Watford, Herts. E2219 A

PILKINGTON BROTHERS, LIMITED

require an

ELECTRICAL ENGINEER

to take charge of the power frequency section of a High Voltage Laboratory, using experimental voltages up to 1300 kV.

The preferred age range is 25–30 and an appropriate university degree is a minimum qualification.

Applications stating age, qualifications, experience and present salary should be addressed to:

Personnel Officer (Graduate Recruitment),
Pilkington Brothers, Limited,
St. Helens, Lancashire
E9415 A

MECHANICAL ENGINEER required by the National Coal Board, Reconstruction Department, Scottish Division, Edinburgh. Salary according to qualifications and experience, within the range £1550–£2150 per annum. The successful applicant will be responsible for advising and guiding the eight Areas in the Division on all aspects of the Reconstruction Programme. Applicants should have had considerable experience in mechanical engineering, preferably in colliery work, and should have the ability to assist Areas in negotiations with plant manufacturers and advise on specifications, tenders and contracts. The successful candidate will also be required to have and maintain an up-to-date knowledge of engineering techniques.—Applications, stating age, education, qualifications, experience, present post and salary, to the Divisional Chief Staff Officer, 3, Eglinton Crescent, Edinburgh, 12. E9456 A

NUCLEAR POWER
GRADUATE MECHANICAL ENGINEER

required for development work (London) area, connected with pressurised water nuclear reactor system components and other high-pressure plant.

Applicants should have served an apprenticeship and have some industrial experience in the field of high-pressure, steam-raising plant.

Please apply in writing, stating age, qualifications and experience, to Staff Manager,
FOSTER WHEELER, LTD.,
3, Ixworth Place,
London, S.W.3. E9313 A

QUALITY CONTROLLER.—Engineer, aged 30–35, required as a Quality Controller, to be responsible for efficient co-ordination of Inspection and Laboratory Departments in a firm manufacturing medium/heavy machinery. Applicants should state details of education, training, salary required, and preference will be given to those with practical experience of quality control.—Applications to Personnel Manager, RUSTON-BUCYRUS, LTD., Excavator Works, Lincoln. E9446 A

QUANTITY SURVEYOR required for service in Tehran as Assistant Superintendent of Technical Services for the National Iranian Oil Company supervising, estimating, quantity surveying and material supply sections of their office. Qualifications: University degree or equivalent and Associate Membership of the appropriate Institution together with experience as a Quantity Surveyor, with estimating, and must have worked in a recognised Quantity Surveyor's Office. Age 35–45, salary in accordance with qualifications, but not less than £2500 free of Income Tax and with accommodation. Two year tours. Prospects of continuous long-term appointment if satisfactory.—Write, giving fullest particulars to Staff Office, Rendel, Palmer and Tritton, Consulting Engineers, 125, Victoria Street, London, S.W.1. E9354 A

REINFORCED CONCRETE DESIGNERS AND DETAILERS required. Salary up to £1000 p.a., according to age and experience. Permanent positions with pension scheme, luncheon vouchers. No Saturdays.—THE CONISTON COMPANY, Eagle House, High Street, Wimbledon, S.W.19. WIM 8521. E2225 A

SALES ENGINEER FOR SOUTH AFRICA, to act as Assistant to Sales Manager in Cape Town. Applicants must have had good basic engineering training and possess experience in machine tools, also presses and plate working machinery. Fullest possible details required of career to date, age and salary, which will be treated in strict confidence. Short listed applicants will be interviewed early in January.—BOX No. E9455, "The Engineer." A

SENIOR APPLICATIONS ENGINEER required by rapidly growing London Lubrication equipment company. Post involves laying out and advising engineering of centralised lubrication schemes and may lead to executive position. Good engineering background, keenness and capacity for hard work essential. Knowledge of steelworks, German and lubrication an advantage. Reply in confidence to Managing Director, stating experience, age and salary required.—BOX No. E2226, "The Engineer." A

THE UNITED GLASS BOTTLE MANUFACTURERS, LTD., ST. HELENS, LANCS.

To strengthen our Design and Development Department we are looking for young men who:
ARE keen to be DESIGN ENGINEERS
HAVE gained H.N.C. Mechanical Engineering or a higher qualification.
ARE capable of converting several years' experience in general engineering into specialised work.
HAVE a creative mind.
ARE ambitious but willing to learn.
HAVE the ability to get on with people.
ARE not afraid of hard work.
HAVE the strength of character to overcome difficulties.

Applications are invited from men who fulfil the above requirements and should be sent to the Personnel Officer. E9386 A

WANTED, BY MEDIUM-SIZED INDIVIDUAL FIRM of manufacturing mechanical engineers in Yorkshire, a man of good all-round standing in mechanical engineering to assist the directors (2) in the daily work, both technical and commercial, design, materials, estimating, testing, overseeing of drawing-office, organisation of expanding machine shop, would be included. A live man is needed and one who would see the firm's point of view. Experience in mechanical power transmission useful, but not essential. Age, say, 35–45.—Write, with full details training and experience, to BOX No. E9322, "The Engineer." A

WORKS MANAGER required by Engineering Company making mechanical handling plants.—BOX No. E2222, "The Engineer." A

YOUNG MAN (30), engineering/mechanical knowledge, required to initiate and develop small department to cost and reduce plastic scrap. West London. Salary £700 to £1000.—BOX No. E2228, "The Engineer." A

YOUNG ENGINEER required for interesting investigation work in Technical Department of large engineering firm in mid-Essex. Practical experience in general engineering desirable. Qualifications should include O.N.C. (Mechanical) or equivalent. Sympathetic consideration will be given to applicants requiring day release for further technical study. Working conditions are good and salary will be commensurate with experience. If desired Saturday morning interviews can be arranged.—Please apply, giving full details of training, practical experience, previous and present positions and age to the Personnel Manager, THE HOFFMANN MANUFACTURING COMPANY, LTD., Chelmsford, Essex. E9431 A

YOUNG ENGINEER, with knowledge of German, to install electro-pneumatic controls. Excellent opportunity for the right man. Must be mobile and capable of working on own initiative.—Replies, in confidence, stating age, experience and commencing salary required, to Managing Director, G. E. SIMM (ENGINEERING), LTD., 27, Broomgrove Road, Sheffield, 10. E9333 A

SITUATIONS VACANT

STEEL FOUNDRY EXECUTIVE

Modern Steel Foundry in Newport, Monmouthshire, producing finest carbon and alloy steel castings, has management opening for man with good commercial sense who "knows his way around the steel casting business." Will be responsible for general foundry management, with particular concentration on handling the business end of a £600,000 annual volume. Salary open and commensurate with experience and results.—Write, Box TE.960, c/o 191, Gresham House, E.C.2. E9450 A

SMITHS MOTOR ACCESSORY DIVISION

require a

TECHNICAL ASSISTANT

for practical and theoretical work on the design of high and low pressure pipe fittings.

The successful applicant, who will probably have H.N.C. and a lively interest in engineering, will be required to work at the Watford Factory.

Good pay and conditions with sickness and pension schemes are available.

Applicants should write fully but concisely, to:—

The Personnel Manager,
The Motor Accessory Division of **S. Smith & Sons (England), Ltd.,**
Otterspool Way, Watford By-pass,
Hertfordshire. E9442 A

COURTAULDS LIMITED, COVENTRY,

have a vacancy for a SENIOR DESIGN DRAUGHTSMAN in the Chemical Engineering Section of Research Department. Applicants should hold a Higher National Certificate in Mechanical Engineering. The Drawing Office deals with a variety of work, concerned particularly with design of experimental chemical plants for the synthetic fibres and plastics industry. Successful applicant would be responsible for the complete engineering design of his projects, including obtaining quotations and negotiating with outside suppliers. A knowledge of plant layout and of structural steelwork would be an advantage. A five-day week. There is a contributory pensions scheme and a co-partnership scheme in operation.—Apply, Labour Office, entrance Pridmore Road. E9448 A

WORKS MANAGER

United Kingdom Manufacturing Plant of world-wide organisation, specialising in medium to heavy type works, desires experienced man, starting as Assistant Works Manager, to replace within three years retiring Works Manager. Future possibility Board seat. Applicants should be aged between 35 and 45, with minimum 10 years' experience in machining methods and machine tool working, and have knowledge of planning, progressing, tool loading and scheduling. Salary open and pension and other benefits.—All applications, which will be treated as confidential, should be sent to Box TE.959, c/o 191, Gresham House, E.C.2. E9449 A

SITUATIONS VACANT

MSL have been retained to advise on the appointment of a

COMMERCIAL MANAGER

This is a new post in a large and developing organization which is making special technical products of national and international importance. He will be responsible to a director and will conduct negotiations at home and abroad with public and private industry for the sale of the organization's products and services; he will also control its licensing and patent sections.

Candidates must be graduates, preferably in engineering or science and have had some years' experience as commercial or sales managers in a company selling a technical product to home and overseas industry. Experience of negotiation with governmental and public authorities would be particularly appropriate. Preferred age 40.

Initial salary up to £4,000 according to experience: contributory pension: help with housing.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.1415, to D. M. Sidney.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E134 A

SITUATIONS VACANT

MSL have been retained to advise on the appointment of a

CHIEF PRODUCTION ENGINEER

for an old established public company in London operating in a number of specialised fields. He will be the Deputy Manager of a department of about 30 specialists and will be the chief adviser of the parent company and its subsidiaries on all production engineering problems.

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E142 A

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E9388 A

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E9414 A

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E3439 A

CJB

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E9425 A

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E9364 MW

Classified Advts. continued on page 120

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PATENTS

AMENDMENT TO PATENT

Notice is hereby given that Deutsche Gold-und Silber-Scheideanstalt vormals Roessler seeks leave to AMEND the COMPLETE SPECIFICATION of the Application for Letters Patent No. 799,005, for an invention entitled "A Method of Uniting Materials by Means of Hard Solders."

Particulars of the proposed Amendments were set forth in the Official Journal (Patents), No. 3644, dated December 17th, 1958.

Any person may give Notice of Opposition to the Amendment by leaving Patents Form No. 36 at the Patent Office, 25, Southampton Buildings, London, W.C.2, on or before January 17th, 1959.

GORDON GRANT,
Comptroller-General.
E9435 H

THE PROPRIETOR of British Patent No. 737771 entitled "A Machine for Operating on Strip Stock and a Reciprocating Slide Feed Therefor," offers same for license or otherwise to ensure its practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, Chrysler Building, New York 17, New York, U.S.A. E9378 H

THE PROPRIETORS of British Letters Patent No. 727,215, for "Cyclone Separators," are desirous of Disposing of the Patent Rights or of negotiating for the granting of Licences to work thereunder.—All enquiries should be addressed to MEWBURN, ELLIS AND CO., Chartered Patent Agents, 70–72, Chancery Lane, London, W.C.2. E9453 H

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By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

1959		*Main location*	*Auctioneers*
January 8	**Miscellaneous stores,** including furniture, hand tools, canvas covers, etc.	General Stores Sub-Depot, **Longtown, Near Carlisle.** (Sale at County Hall, Carlisle.)	**HARRISON & HETHERINGTON, LTD.** (Dept. L.), Botchergate, Carlisle. (Tel.: 26292.)
January 14	**Machine tools and miscellaneous stores,** including:	Technical Stores Depot, **Old Dalby, Melton Mowbray, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Normal Street, Melton Mowbray, Leics. (Tel.: 3081.)
	Centre and turret lathes; millers; cylinders, bearing and other borers; pillar drills; hacksaws; universal grinders; pipescrews; sawbenches; morticers; planers and thicknessers; wood lathes; 150 saw blades; engine belting; 22kVA mobile generating sets; test sets; etc.		
January 20-21	**Vehicles and miscellaneous stores**	Central Ordnance Depot, **Bicester, Oxon.**	**MIDLAND MARTS, LTD.** (Dept. L), Market Square, Bicester, Oxon. (Tel.: 81.)
January 29	**Machine tools, plant,** etc.	M.O.S. Sub Depot, Queens Drive, **Kilmarnock, Ayrshire.**	**SHIRLAW, ALLAN & CO.** (Dept. L), Keith Street, Hamilton, Lanark. (Tel.: Hamilton 63.)

SALES BY TENDER

1. To be sold as one lot. Mesh belt conveyor hardening and tempering furnaces by G.W.B. Electric Furnaces, Ltd., Dudley. Complete with Dawson degreaser, all unused and unerected. 400V, 3ph., 50c. hardening, 45kW, 1000 deg. Cent., tempering 500 deg. Cent. Located at Rhydymwym, North Wales.

2. New Britain 6 spindle 1⅛in. automatics; Schiess vertical borers; radial drills; die sinkers; gear hobbers; internal grinders; turret lathes, etc. Located in the Midlands.

Tenders must be submitted by January 19.

APPLICATIONS: (*a*) for catalogues for the auction sales should be made only to the auctioneers shown above (price of catalogues 1s. 0d., P.O. *only*).
(*b*) for Tender Forms, stating which tender is required, should be made to the Ministry of Supply, Directorate of Disposals, First Avenue House, High Holborn, London, W.C.1.

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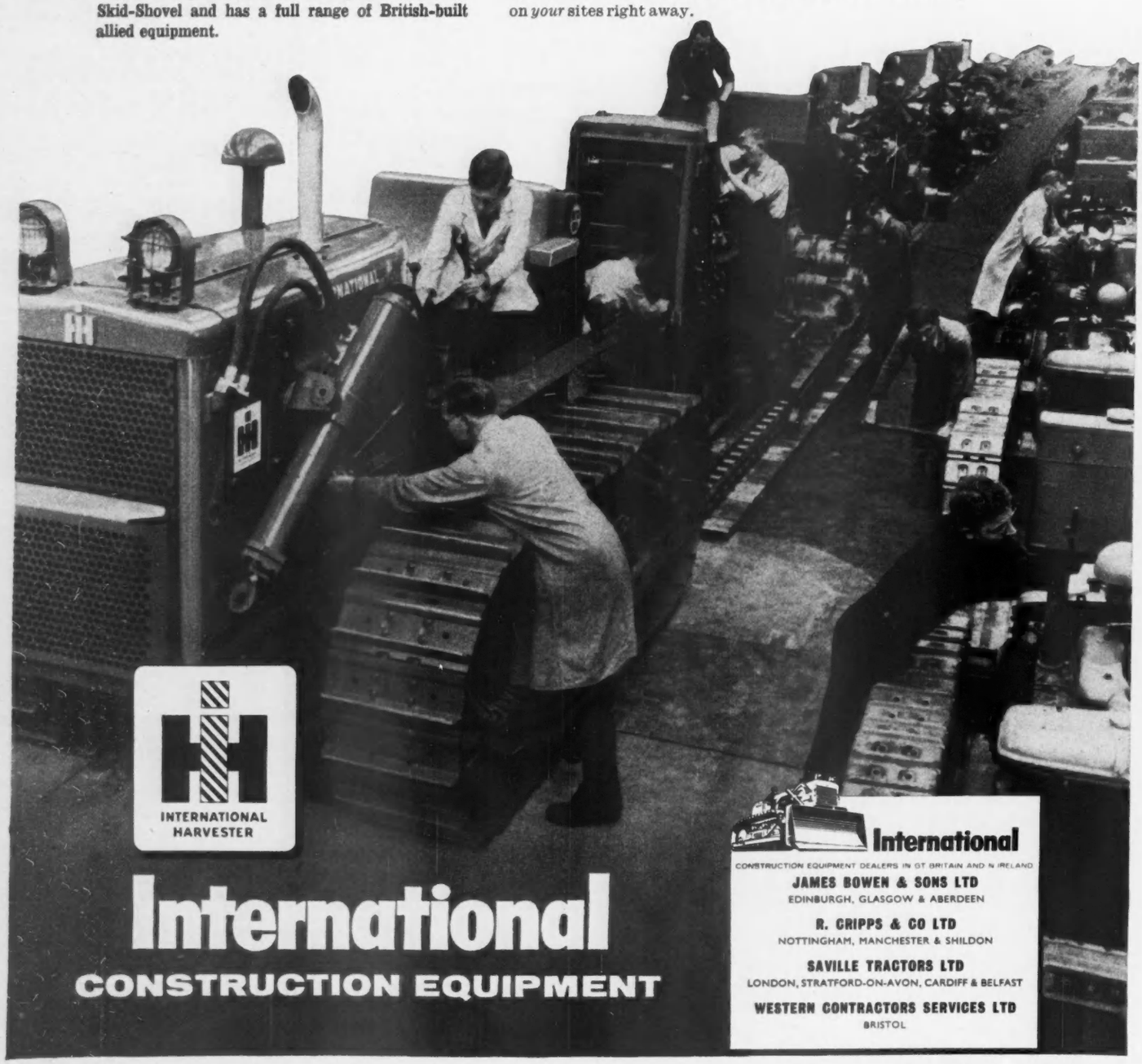

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INDEX TO ADVERTISERS

PAGE

AB Atlas Copco/Sweden..... 11
Abboflex, Ltd..... 96
Abbott & Co. (Newark), Ltd.... 78
Abix (Metal Industries), Ltd. ... 74
Accurate Recording Instrument Co. 112
Acheson Colloids, Ltd..... 94
Aeraspray Associated, Ltd.....123
Alston Foundry Co., Ltd..... 51
Amal, Ltd..... 37
Andre Rubber Co., Ltd..... 70
Ashmore, Benson, Pease & Co. 9
Automotive Products Co., Ltd.115

B.S.A. Tools, Ltd..... 60
Barimar, Ltd. 15
Barlow-Whitney, Ltd 7
Barron, W. S., & Son, Ltd..... 34
Beardmore, W., & Co., Ltd..... 67
Berry, H., & Co., Ltd..... 6
Birfield Industries, Ltd..... 47
Birlec, Ltd..... 61
Blakeborough, J., & Sons, Ltd..... 18
Bochumer Verein..... 103
Booth, J., & Bros. 92
Bostock & Bramley, Ltd..... 98
Braby, F., & Co., Ltd..... 36
Brackett, F. W., & Co., Ltd. 62
Brady, G., & Co., Ltd..... 103
British Electrical Development Association..... 5
British Electrical Repairs, Ltd. 78
British Paints, Ltd..... 19
British Steam Specialties, Ltd. 20
British Thomson-Houston Co., Ltd. 104
Bronx Engineering Co., Ltd.... 62
Broom & Wade, Ltd..... 76
Brown, D., Corporation (Sales), Ltd..... 53
Brown, Lenox & Co., Ltd..... 110
Brownlie & Murray, Ltd..... 25
Budenberg Gauge Co., Ltd..... 34
Burnand, W. E., & Son, Ltd... 57
Butcher, H., & Co..... 121
Butterfield, W. P., Ltd..... 74

C. & M. Engineering Co., Ltd. 93
C.A.V., Ltd..... 31
C.J.C. Developments (Portsmouth), Ltd. 96
Caird & Rayner, Ltd..... 23
Callow, F. E. (Engineers), Ltd. 90
Carlisle, C. G., & Co., Ltd..... 56
Carr, C., Ltd..... 7
Carter, B. & F., & Co., Ltd.... 82
Chatwin, T., & Co..... 4
Clancey, G., Ltd..... 95
Cleveland Bridge & Engineering Co., Ltd..... 54
Clyde Crane & Booth, Ltd..... 92
Clyde Crane & Engineering Co. 92
Cohen, G., Sons, & Co., Ltd.. Cover ii–83
Colt Ventilation, Ltd..... 33
Coltman, Walter W., & Co. (Boilers), Ltd..... 62
Cort, R., & Son, Ltd..... 16–17
Cox & Danks, Ltd..... 93
Crane, Ltd..... 57
Craufurd Fabrications, Ltd..... 79
Craven Bros. (Manchester), Ltd. 91
Crofts (Engineers), Ltd....106–107
Cross Manufacturing Co. (1938), Ltd..... 111
Cuxson, Gerrard & Co., Ltd... 81

Darlington Forge, Ltd..... 50
Distington Engineering Co., Ltd. 87
Drummond-Asquith (Sales), Ltd. 27
Drysdale & Co., Ltd..... 99
Dustraction, Ltd..... 54

Edwards, F. J., Ltd..... 3
Electromagnets, Ltd..... 23
Elliott Bros. (London), Ltd..... 77
Elliston, Evans & Jackson, Ltd. 96
English Electric Co., Ltd..... 84
Evans, F. W. Ltd..... 57
Evans, J., & Sons (Wolverhampton), Ltd..... 78

Farmer, L., & Sons..... 121
Fenter, Ltd..... 20
Ferranti, Ltd..... 72
Filton, Ltd..... 37
Firth, T., & Brown, J., Ltd..... 52
Firth-Vickers Stainless Steels, Ltd..... 41
Fleming & Ferguson, Ltd..... 39
Fluxite, Ltd. 96
Follsain-Wycliffe Foundries, Ltd..... 74
Foord, J., & Co..... 121
Forster, T. S., & Sons, Ltd.... 15
Foster Wheeler, Ltd..... 90
Fuller, Horsey, Sons & Cassell 121

Globe Pneumatic Engineering Co., Ltd. 35
Gloucester Foundry, Ltd..... 75
Goodyear Tyre & Rubber Co. (Great Britain), Ltd..... 61

Harland Engineering Co., Ltd. 8
Harvey, G. A., & Co. (London), Ltd..... 80
Hawke Cable Glands, Ltd.....101
Heap, J., & Co., Ltd..... 39
Heenan Group, Ltd..... 117
Hermetic Rubber Co., Ltd..... 90
Higgs Motors, Ltd..... 21
Hill, J., & Sons (Ironfounders), Ltd..... 19
Hill Top Foundry Co., Ltd..... 63
Hingley, N., & Sons (Netherton), Ltd..... 55
Holbrook..... 14
Hopkinsons, Ltd..... 7
Hudson, R., Ltd..... 59
Huntingdon Rubber Co., Ltd. 4

Ilford, Ltd..... 66
Imperial Chemical Industries, Ltd..... 65
Ince Forge Co..... 25
International Combustion Products, Ltd..... 29
International Harvester Co. of Great Britain, Ltd.....122
International Meehanite Metal Co., Ltd. 88

Ironsides Lubricants, Ltd.....120
Isler, C., & Co., Ltd. 113

Jarrow Metal Industries, Ltd.... 86
Jenkins, R., & Co., Ltd..... 71
Jenks Bros., Ltd..... 81

Kay & Co. (Engineers), Ltd.....114
Kay, S., Rubber Co., Ltd..... 63
Kearns, H. W., & Co., Ltd..... 64
Kenilworth Manufacturing Co., Ltd..... 54
Krupp, Fried..... 45

Lake & Elliot, Ltd.....113
Lockwood & Carlisle, Ltd..... 58

Maclellan, P. & W., Ltd..... 93
Marbaix, Gaston E., Ltd..... 25
Markland Scowcroft, Ltd..... 68
Marsden, S., & Son, Ltd..... 93
Marshall Fleming & Co., Ltd. 34
Maxim Conveyors (England), Ltd..... 3
Metallic Valve Co., Ltd.....102
Metropolitan-Vickers Electrical Co., Ltd. .....Cover iv–44
Midland Industries, Ltd..... 63
Millers Rings, Ltd.....101
Mirrlees (Engineers), Ltd. 23
Morris, B. O., Ltd..... 69
Morris, H., Ltd..... 48
Murex Welding Processes, Ltd. 28

Neco Geared Motors, Ltd..... 15
Newall, A. P., & Co., Ltd..... 14
Newall Group Sales, Ltd..... 13
Newalls Insulation Co., Ltd..... 75
Newbury Diesel Co., Ltd..... 37
Norris Brothers, Ltd..... 37
Nuclear Power Plant Co., Ltd. 32
Nu-way Heating Plants, Ltd. ..124

Osborn, S., & Co., Ltd..... 22

Parker, F., Ltd..... 98
Peckett & Sons, Ltd..... 26
Perry Barr Metal Co., Ltd..... 30
Pinchin, Johnson & Co.....102
Pitman, Sir Isaac, & Sons, Ltd.119
Pittam, J., & Co..... 46
Planters Engineering Co., Ltd.114
Pool, J. & F., Ltd.....111
Power-Gas Corporation, Ltd... 9
Power Petroleum Co., Ltd..... 42
Precision Rubbers, Ltd.....114
Priest Furnaces, Ltd..... 34
Priestman Bros., Ltd..... 97
Prodorite, Ltd. 105
Pulsometer Engineering Co., Ltd. 94

Ransomes, Sims & Jefferies, Ltd. 93
Reed Crane & Hoist Co., Ltd. 38
Reid Gear Co., Ltd.....105
Rhodes, Gill & Co., Ltd..... 58
Richardsons Westgarth (Hartlepool), Ltd..... 2
Robertson Thain, Ltd.....109
Robinson, L., & Co. (Gillingham), Ltd.....102
Ross, R. G., & Son, Ltd..... 72
Rotork Engineering Co., Ltd.... 25
Ruston & Hornsby, Ltd..... 89

Sadi Engineering Co., Ltd..... 60
Sankey, J., & Sons, Ltd.....100
Saunders-Roe, Ltd. 35
Savery, T., Pumps, Ltd.....115
Schieldrop & Co., Ltd.....108
Scriven Machine Tools, Ltd.... 82
Sheffield Wire Rope Co., Ltd.... 58
Small & Parkes, Ltd..... 95
Smedley Bros., Ltd..... 25
Smethwick Drop Forgings, Ltd. 43
Smith, H., & Co. (Possil), Ltd. 20
Smith, J. W. (Coventry), Ltd.... 39
Smith, T., & Sons (Rodley), Ltd. .....Cover iii
Smiths Industrial Instrument Division..... 24
Spelleken, H., Nachf. Kom.-Ges. 93
Spencer - Bonecourt - Clarkson, Ltd. 120
Spirax-Sarco, Ltd..... 81
Standard Telephones & Cables, Ltd..... 37
Sturtevant Engineering Co., Ltd. 82
Sugden, T., Ltd..... 94

Taylor Industrial Clutches.....111
Taylor, Taylor & Hobson, Ltd. 4
Teddington Aircraft Controls, Ltd. 91
Telco, Ltd..... 20
Thompson, J., Group..... 10
Thornycroft, J. I., & Co., Ltd...112
Tinsley, H., & Co., Ltd.....112
Trewhella Bros. Pty., Ltd..... 82

United Dominions Trust, Ltd. 38

Vaughan, E., & Co., Ltd..... 95
Vickers - Armstrongs (Engineers), Ltd..... 49
Vulcan Boiler & General Insurance Co., Ltd..... 23

Ward, T. W., Ltd.....120
Warren-Morrison, Ltd..... 82
Weir Valves, Ltd..... 73
Wellington Tube Works, Ltd.... 99
West Ham Testing Laboratory 57
Westool, Ltd..... 26
West's Piling & Construction Co., Ltd.....Cover i
Wharton Crane & Hoist Co., Ltd. 85
Wheatley, Kirk, Price & Co....121
Wheatley & Whiteley.....101
Whitecross Co., Ltd..... 3
Widnes Foundry & Engineering Co., Ltd..... 40
Wiggin, H., & Co., Ltd.....101
Wilkinson Rubber Linatex Ltd.. 55
Wilmot Breeden, Ltd..... 12
Winn, W. M., Ltd..... 62
Wiseman, A., & Co., Ltd..... 77
Woods of Colchester, Ltd.....111

Youngs (Lifting Appliances), Ltd. 115

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They have porcelain enamelled back screen as standard and can also be supplied with similar water washed side screens. It is difficult for anyone who has not seen them to visualise the immense superiority and advantages. Only normal lighting is necessary to throw up the work with great clarity. The interior remains bright, clean and new looking. The booths are a source of pride to those who use them and promote morale and care of the work done in them.

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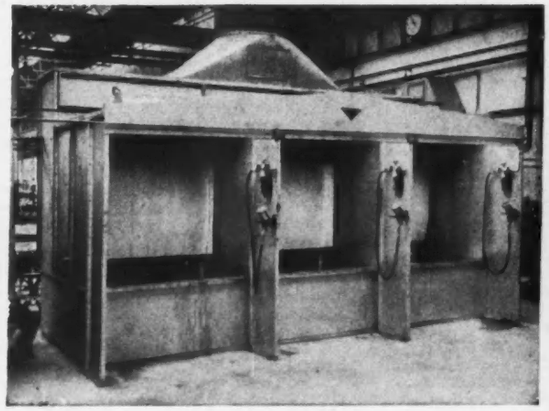

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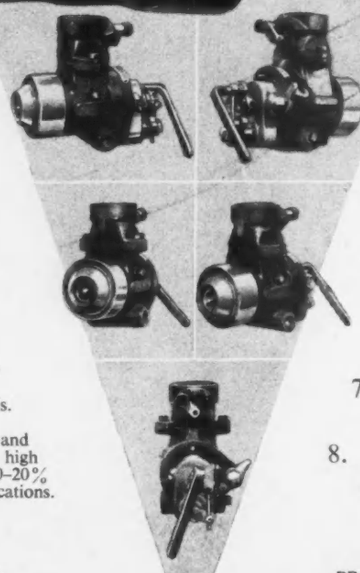

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1. ONE LEVER controls both oil and air, keeping the ratio constant from maximum to minimum firing rate. Easily and efficiently operated by unskilled labour.
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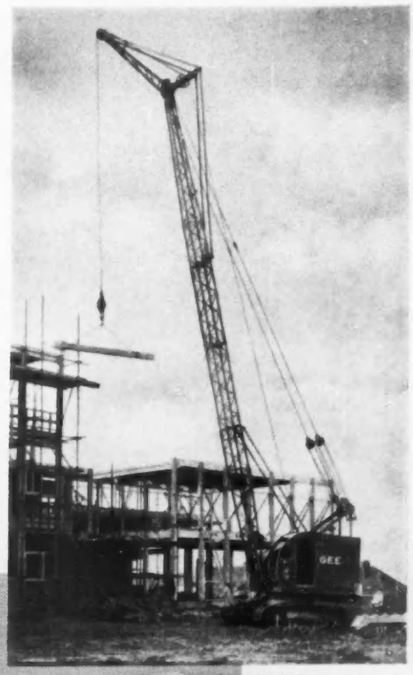
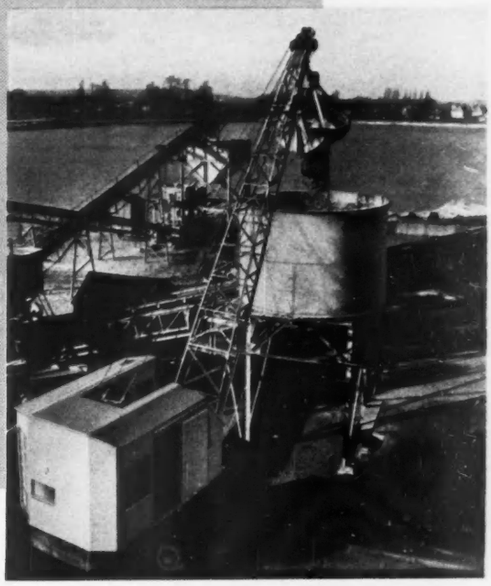
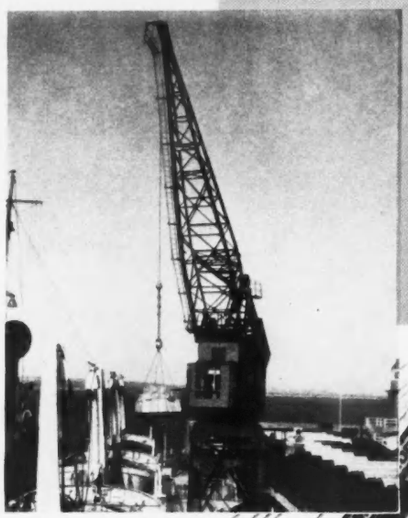
A Smith Truck-Crane lifting a 68ft. Dorman Long 36"×16½" Universal Beam on a by-pass bridge on the A.I. Trunk Road.



SCHOOL BUILDING
A Smith 21 Crawler Crane lifting concrete units into position during the building of a new school.



SAND AND GRAVEL
A Smith 5-ton diesel loco crane feeding a loading hopper.



CARGO HANDLING
A Smith 7½ ton electric level-luffing portal crane installed at Rosslare Harbour.

GRAB DUTIES
A Smith 5-ton diesel shunting crane unloading railway wagons at the United Glass Bottle Co. Ltd., St. Helens.

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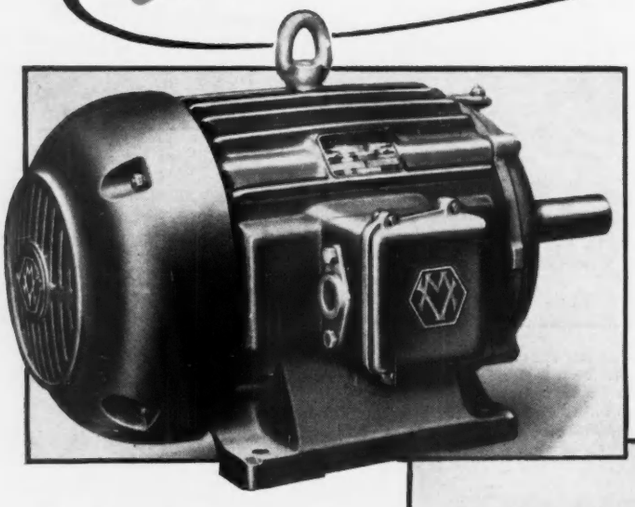

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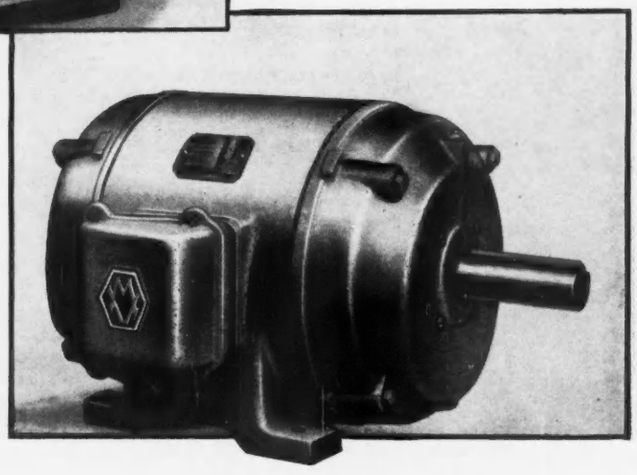
TEFC ENCLOSURE
1-20 hp* (4-pole)

**Additional Ratings not included in BS2083 are also available up to 50 hp.*

With the introduction of the new BS2960/1958, squirrel-cage motors with Standardised Dimensions can now be supplied with VENTILATED as well as TEFC enclosures. Metrovick Motors designed and built to these specifications are known as Types KN-C and KN-B respectively.



Type KN-C to BS2960/1958
VENTILATED Enclosure from
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